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MULTIFREQUENCY DUAL RIDGE WAVEGUIDE SLOT ANTENNA

Filed July 25, 1963

2 Sheets-Sheet 1

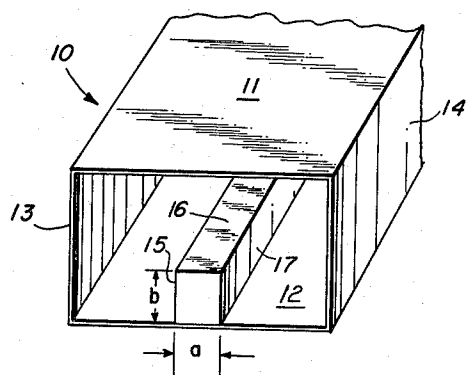


FIG. 1
(PRIOR ART)

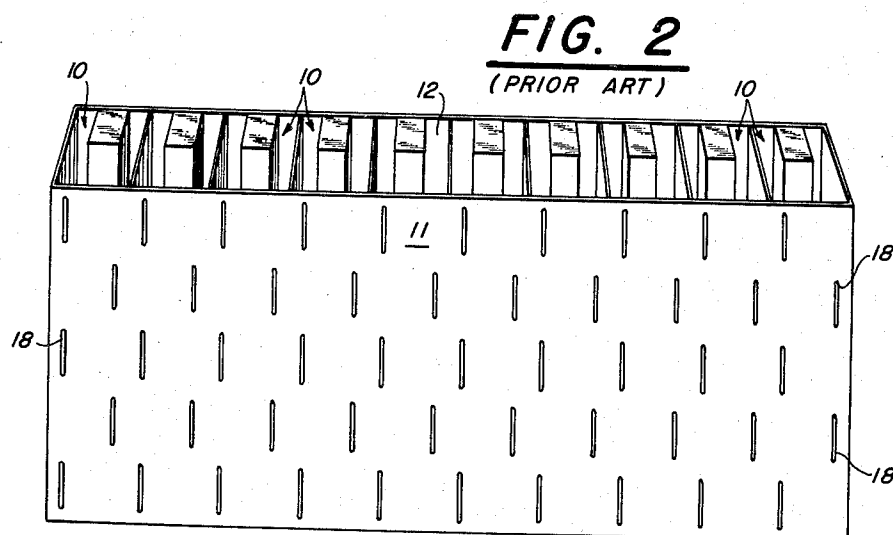


FIG. 2
(PRIOR ART)

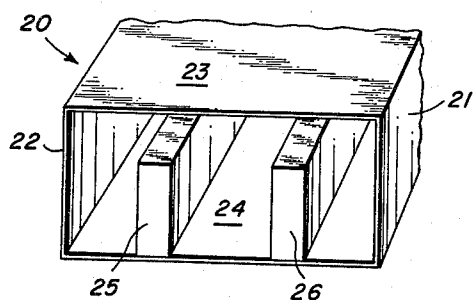


FIG. 3

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2 Sheets-Sheet 2

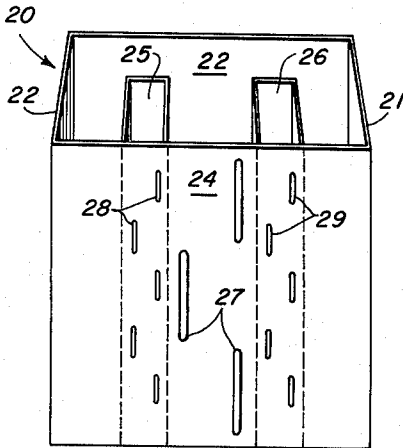


FIG. 4

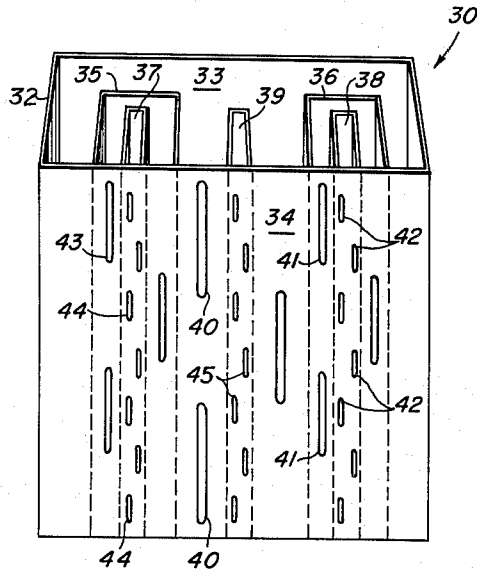


FIG. 5

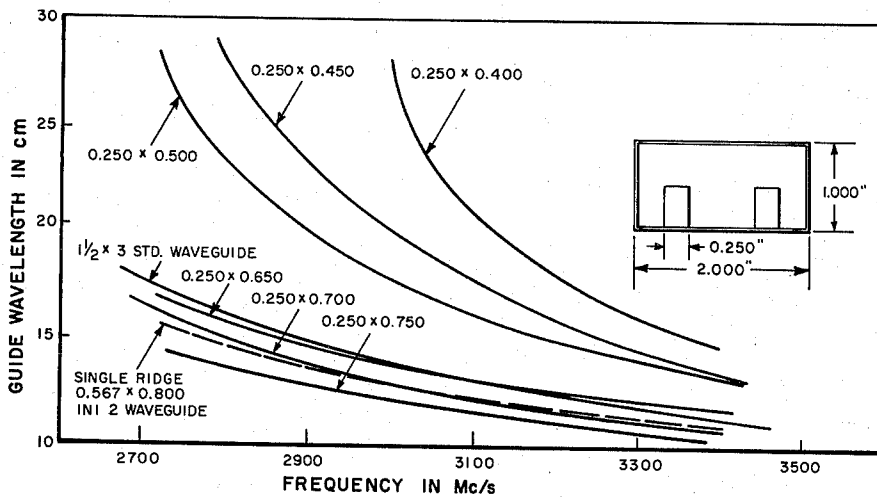


FIG. 6

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MULTIFREQUENCY DUAL RIDGE WAVE- GUIDE SLOT ANTENNA

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6 Claims. (Cl. 343-771)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The present invention relates to an improved antenna and more particularly, to an improved ridged waveguide antenna and specifically, to a dual ridge waveguide antenna.

The present invention represents an extension of the principles set forth in co-pending application Serial No. 167,983, filed January 22, 1962, titled "Ridged Waveguide Antenna." In the aforementioned co-pending application the requirements of radiation and receiving of electromagnetic energy are set forth as well as prior art techniques and shortcomings.

Briefly however, a necessary requirement for the design of multi-element slotted arrays for low-side lobe application is an element spacing of approximately one half free space wave length. Because of the physical size of standard waveguides however, this requirement cannot be met. In order to obviate this shortcoming a ridge, or metal strip is inserted into the waveguide and fastened to one wall as set forth in FIG. 1 and by so doing the range of required frequencies can be extended to lower frequencies. The wave lengths of the frequencies propagated can be controlled to some degree by a proper choice of the ridge parameters a and b in FIG. 1. This technique has been used for planar arrays and is quite well known. The waveguide is then slotted in various configurations to give a desired radiation pattern. Individual elements i.e. individual arrays are then assembled in an array of arrays as shown in FIG. 2.

In many instances in antenna design, the use of the same area occupied by an antenna for more than one function is desirable. This may be especially so on small ships where space may be at a premium. Several schemes are in present use which utilize the same aperture area for both radar and identification function. For the slotted array case even with the use of the ridge and the adjacent slot as set forth in the aforementioned co-pending application, the possibility of using the aperture for other functions is minimized due again to the one-half free space wave length spacing required for low-side lobes and the prevention of a multiplicity of beams.

An object of the present invention is to provide an improved ridged waveguide antenna.

A further object of the present invention is to provide an improved ridged waveguide antenna wherein two or more functions may be carried out in the same antenna aperture.

A further object of the present invention is to provide an antenna array which has the advantages of an adjacent slotted ridged waveguide antenna and in addition is capable of performing two or more functions in the same antenna area.

Another object of the present invention is to provide an antenna having low side lobes and which prevents a multiplicity of beams.

The invention as illustrated and described in conjunction with the accompanying drawings wherein:

FIG. 1 is an embodiment of the prior art single element ridged waveguide;

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FIG. 2 is an illustration of a prior art array of arrays of FIG. 1;

FIG. 3 illustrates one embodiment of the present invention showing the placement of two ridges in a standard waveguide on the same wall;

FIG. 4 illustrates an embodiment of the present invention showing the placement of the slot in the wall of the ridged waveguide;

FIG. 5 illustrates another embodiment of the invention; and

FIG. 6 is a graph of waveguide characteristics.

In the prior art ridged waveguide antennas a conventional rectangular waveguide 10 having walls 11, 12, 13 and 14 is utilized. A loading ridge is placed on one wall, such as 12, and has walls 15, 16 and 17 defining the ridge area. The dimension b of walls 15 and 17 of the loading ridge define the extent to which the ridge extends into the interior of the waveguide 10 and a dimension a which is symmetrical about the center line of the waveguide 10 defines the length of wall 16.

An array of arrays, such as those set forth in FIG. 1, would be utilized as set forth in FIG. 2 wherein individual arrays 10 have a loading ridge on one wall and slots cut in the wall opposite the wall upon which the loading ridge is mounted. Thus, with respect to one of the arrays 10 slots 18 are cut in wall 11 which is opposite wall 12 upon which the loading ridge is mounted.

In the co-pending application Serial No. 167,983, filed January 22, 1962, titled "Ridged Waveguide Antenna" of Joseph H. Provencher radiating slots are cut in the same wall that the loading ridge is mounted on. In the addition radiating slots are also cut in the wall upon which the loading ridge was mounted and within the area defined by the loading ridge. By doing this it was found that two different frequencies of propagation could be utilized within the same aperture. However, the side lobe pattern is not ideal nor are a multiplicity of beams prevented.

In the present invention as shown in FIG. 3, a section of rectangular waveguide such as 20 having opposite walls 21, 22, and opposite walls 23, 24 is utilized and two loading ridges as at 25, 26 are mounted on one of the walls as on wall 24. In FIG. 3 the loading ridges 24 and 25 are illustrated as being symmetrical about the longitudinal center axis of the waveguide element 20.

FIG. 4 illustrates an individual array and the placement of slots in the array within the areas bounded by the loading ridges. Again a section 20 of rectangular waveguide is utilized having opposite walls 21, 22 and opposite walls 23, 24. Loading ridges 25 and 26 are again attached to wall 24. Slots 27 are cut in the wall 24 of the waveguide element 20 within the area bounded by the loading ridges 25 and 26 and extend along the longitudinal axis of the waveguide 20. These are cut slightly greater in length than one half the free space wave length at the frequency of propagation and are spaced longitudinally one half the free space wave length.

In addition, radiating slots 28 are cut in the wall 24 within the area bounded by loading ridge 25 and slots 29 are cut in wall 24 within the area bounded by loading ridge 26. In this embodiment using dual ridges the requirement for approximately one half wavelength spacing is met while side lobes are suppressed and a multiplicity of beams prevented.

The embodiment of FIG. 5 illustrates an array which is capable of performing three functions within the same aperture. In this instance a rectangular waveguide element 30 is used. The waveguide has opposite walls 31, 32 and opposite walls 33, 34. Mounted on one wall 34 are loading ridges 35 and 36. Mounted within loading ridge 35 is another loading ridge 37 while mounted within

loading ridge 36 is another loading ridge 38. Mounted on the center line of waveguide element 30 is another loading ridge 39 approximately the same dimension as 37, 38. Slots 40 are cut in the wall 34 extending longitudinally of the axis of the waveguide 30 and outside the area bounded by loading ridges 35, 36. Slots 41 are cut in the wall 34 outside the area bounded by loading ridge 38 and within the area bounded by loading ridge 36. In addition, the face of the wall 34 has slots 42 cut in it within the area bounded by loading ridge 38.

The same applies to loading ridge 35. Within the area bounded by it and in the face of wall 34 and outside the area bounded by loading ridge 37 are slots 43. In addition, slots 44 are cut in the face of wall 34 within the area bounded by loading ridge 37. Slots 45 are cut in face of wall 34 within the area bounded by loading ridge 39.

By utilizing such a configuration, i.e., through the use of loading ridges within loading ridges a multiplicity of frequencies may be attained, for example, as regards a radar system. The extension of the dual ridge technique to the radar array is a logical sequence since a high gain requirement is usually desired, and this may be achieved by placing individual arrays or elements in a side-by-side manner in a large array. The typical example might require the long range search radar, the height finding radar, and identification function to operate simultaneously on a small ship. The three antennas for these three independent operations could all occupy the same aperture area in an array comprising individual elements such as those set forth in FIG. 5. The three waveguides required could be cascaded into one large flat planar array.

It is to be noted however, that the invention is limited by the physical sizes of the waveguides used, and these are necessarily dictated by desired operating frequencies. By judicious choice of the spacing, proper ridge parameters and the operating frequencies, a dual ridge array capable of any independent operation in three frequency bands can be realized. The concept could also be extended to a circular array or to other configurations by proper choice of spacing in elements.

Spacing of the slots is approximately one half guide wavelength and the length of the slots is approximately one half guide wavelength as set forth in the aforementioned co-pending application.

In the operation of the embodiments of the present invention the antennas may be center-fed or end-fed, short circuited or loaded at the end. In addition, through the use of a slot longer than one half wavelength at the operating frequency, the bandwidth restrictions of the resonant slot are avoided. The shorting plate at the end of the waveguides and the manner in which the elements are fed is not illustrated in that they form no part of the present invention.

With the configuration of the present invention the interior areas bounded by the ridges may be used as additional waveguides at higher frequencies and, additionally, these waveguides may in turn be fitted with ridges so that the scheme may be utilized as a cascaded system, being limited only by the physical sizes of the waveguides

used. This allows the use of a number of frequency bands in the same aperture area each independently fed, and capable of operation simultaneously. Experimental data, which is set forth in FIG. 6, taken with a dual ridge waveguide demonstrates that the propagation characteristics of standard waveguides and single ridge waveguides can be duplicated in the dual ridge waveguides. The comparison of these waveguides characteristics and configurations in regard to the guide wavelengths are given in FIG. 6. The combinations of these two facts allow the construction of multiple band arrays in the same aperture.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. An antenna comprising:

a rectangular waveguide;

a multiplicity of loading ridges mounted on and extending internally of the waveguide;

radiating slots located adjacent to the loading ridges in the same wall that the loading ridges are mounted on for radiating energy at a first frequency; and

other radiating slots located in the same wall that the loading ridges are mounted on and within the areas bounded by said loading ridges for radiating energy at another frequency.

2. An antenna as set forth in claim 1 wherein:

said radiating slots located adjacent to said ridges and said other slots located within the areas bounded by said ridges are parallel to the axis of propagation of energy in said waveguide.

3. An antenna as set forth in claim 1 wherein:

the dimensions of certain of the loading ridges differ so that the wave length of frequencies propagated from the ridges differ.

4. An antenna as set forth in claim 1 wherein:

said multiplicity of loading ridges comprises at least a first and second group;

said first group having different physical dimensions than the second group; and

one of said first and second groups being mounted within the other of said first and second groups.

5. An antenna as set forth in claim 1 wherein:

said multiplicity of loading ridges are mounted on the same wall of the waveguide.

6. An antenna as set forth in claim 4 wherein:

said other radiating slots are located within the areas defined by said at least first and second groups;

the radiating slots associated with said first group lying outside the areas defined by said second group; and

the radiating slots associated with the second group lying outside the areas defined by said first group.

References Cited by the Examiner

UNITED STATES PATENTS

2,807,018 9/57 Woodward ----- 343-770

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