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ANTENNA HAVING RING WAVEGUIDE TWO WAVELENGTHS LONG FOR FEEDING TWO SLOTS IN DIAMETRICALLY OPPOSED PORTIONS THEREOF

Filed March 30, 1960

FIG. 4

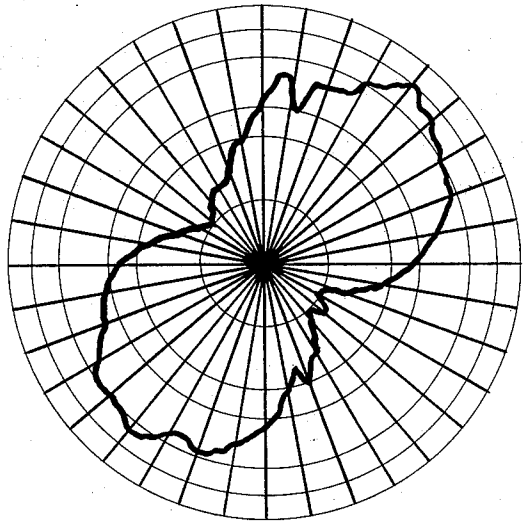


FIG. 1

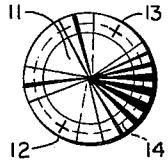
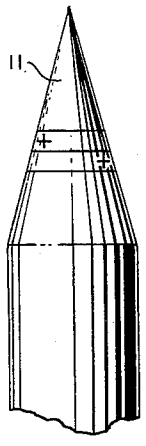


FIG. 2



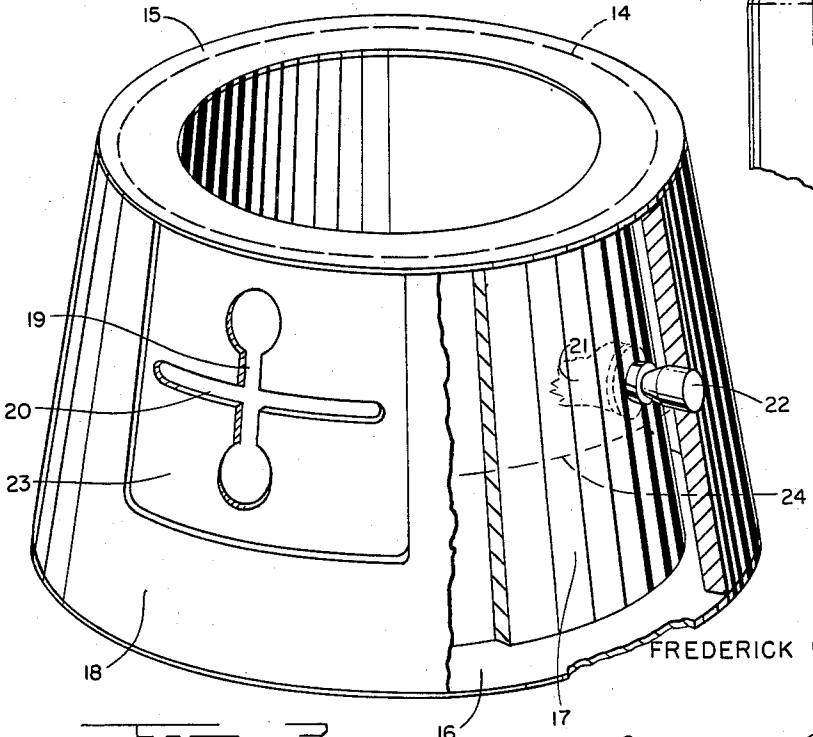


FIG. 3

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ANTENNA HAVING RING WAVEGUIDE TWO WAVELENGTHS LONG FOR FEEDING TWO SLOTS IN DIAMETRICALLY OPPOSED PORTIONS THEREOF

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5 Claims. (Cl. 343—708)

This invention relates in general to microwave antenna structures and in particular to antenna structures suitable for use on airborne vehicles.

It is well recognized in high altitude research involving airborne vehicles that the size, weight, air resistance, etc., of all elemental portions of the vehicle be minimized. In order to minimize weight, it is common practice to employ a single antenna for both transmission and reception of radiant energy. This single antenna is generally mounted on the exterior of the vehicle and is frequently enclosed in a dome housing to reduce air resistance. An external housing arrangement is not the ideal solution, of course, since the reduction in air resistance is necessarily accompanied by an increase in size and weight. In general it has been found that exterior mounted elements, whether enclosed in a housing or not, adversely affect the aerodynamic characteristics of the vehicle to some extent and are to be avoided wherever possible.

Accordingly, it is an object of this invention to provide an antenna assembly for an airborne vehicle which does not impair the aerodynamic characteristics of the vehicle.

Another object of this invention is to provide an extremely compact antenna assembly for aircraft which has a radiation pattern with a minimum number of nulls.

A further object is to provide an antenna system which utilizes a portion of the existing structure of the airborne vehicle.

Other objects will become apparent upon a more comprehensive understanding of the invention for which reference is had to the following detailed description and drawing, wherein:

FIG. 1 is a top view of the ring waveguide antenna of this invention in a typical installation on an airborne vehicle.

FIG. 2 is a side view of the ring waveguide antenna of this invention in another installation.

FIG. 3 is a pictorial cut-away view of the ring waveguide antenna of this invention in a typical installation such as shown in FIG. 1.

FIG. 4 is a graphical presentation of a typical radiation pattern for the antenna of this invention.

Briefly, the device of this invention involves a circular waveguide antenna wrapped around the inside of a conical structure which, in the depicted embodiment, is the nose cone of a missile. The circular waveguide antenna has crossed slots cut into the outer waveguide wall, together with a selectively disposed point of feed whereby a single effective radiation pattern is obtained with maximum radiation and minimum absorption within the antenna itself.

Referring now to FIG. 1, a tubular conical end-section **11** of an airborne vehicle is shown with the ports or slot radiators of the ring waveguide antenna indicated at **12** and at **13**. The dotted line indicated at **14** represents the mean circumference of the ring waveguide and for reasons which will become apparent hereinafter is preferably equal to twice the wavelength at the operating frequency. Also, it will be noted that the slot radiators are diametrically disposed in this preferred embodiment. The end section may be, but not necessarily, the forward or nose end of the vehicle.

FIG. 2 is a side view of a tubular conical end-section of the type shown in FIG. 1. In FIG. 2, two ring waveguide antennae are incorporated one above the other. It will be appreciated that a greater number of ring waveguide antennae may be incorporated within the conical end-section **11**, if desired, and that each antenna operates independently of the rest. As mentioned above, it is common practice to employ a single antenna for both transmission and reception rather than a separate antenna for each. Several antennae would be desirable, for example, where a multifrequency operation is involved and the frequencies employed are widely separated.

In FIG. 2 the end-section is made of an electrically conductive material such as aluminum alloy, and the end-section forms the outer wall of each of the antennae. It will be appreciated that the outer wall of the antennae might be separated from the end-section **11**, if desired, and that in such instance the end-section, as well as the remainder of the vehicle, may be of any material suitable for space travel.

FIG. 3 depicts a single ring waveguide antenna cut away to more clearly disclose the construction of a preferred embodiment of the invention. In FIG. 3 the antenna comprises a closed ring rectangular waveguide having top and bottom walls **15** and **16** as well as substantially parallel inside and outer walls **17** and **18**. On opposite sides of the ring crossed slots are cut in the outer waveguide wall, only one of which is shown in the drawing. In this embodiment, the crossed slots consist of a transverse slot **19** and a longitudinal slot **20**. A standard coaxial-to-waveguide feed is employed in this embodiment with the outer conductor **21** of the coaxial line electrically connected to the inside wall **17** and with the inner conductor **22** of the coaxial line electrically connected to the outer wall **18** of the waveguide ring. It will be appreciated that the tapered center conductor depicted in FIG. 3 affords better impedance matching between the coaxial line and the waveguide. The type of feed employed is not, of course, critical to the device of this invention and other types of feed known in the art may be substituted as desired.

The type of feed shown in FIG. 3 is generally known as a quarter wavelength transformer. The impedance match of the coaxial connector in the shown embodiment is found to be less than 1.2:1 (VSWR) over a band of 200 mc.

In FIG. 3, the transverse slot **19** is shown in the form of a dumbbell. It will be appreciated that this is standard technique in the art where the overall length of the transverse slot is limited and must be shortened. It also will be appreciated, however, that with a judicious choice of waveguide width in the order of .7λ at the operating frequency, one may employ ordinary slots.

Likewise, it will be appreciated that this invention is not limited to radiators of the particular cross slot variety shown in the preferred embodiment and that other slot configurations which perform in similar fashion may be substituted as desired.

Employing the cross slot arrangement, it has been found advisable to select the position of the transverse slot such that the normalized resistance $(R/ZO)=2$. Likewise, it has been found advisable to select the position of the longitudinal slot such that the normalized conductance $(G/Yo)=2$. Employing this configuration it has been found that all energy is extracted from the waveguide, thus a provision to absorb energy past the slot is unnecessary and the waveguide may remain an open ring.

Also in FIG. 3 a Teflon cover, indicated at **23**, is employed in the crossed slot area for obvious reasons. It will be appreciated that the employment of Teflon cover necessitates a slight modification of the slot dimensions

and that such modification may be accomplished using standard techniques in the art.

FIG. 4 is a graphical showing of a radiation pattern for the embodiment shown in FIG. 1. It will be appreciated that the radiation pattern shown in FIG. 4 is merely illustrative of relative field strength and that magnitude is a direct function of the magnitude of the energy fed to the antenna. It has been found that the radiation pattern of the array of two cross-slot radiators may be varied by changing the relative position of the transverse and longitudinal slots. The phasing between the slot pairs may be varied by moving the feed point around the ring. For example, a longitudinal slot on one side of the ring may be moved an equal distance across the center line of the waveguide indicated in FIG. 3 at **24**, to give a 180° phase shift.

The device of this invention provides a small diameter structure which affords a radiation pattern with a minimum number of nulls. In addition, by reason of its small diameter and uniform configuration, the device of this invention is readily adaptable to extreme nose cone installations which is a preferred antenna location on most airborne vehicles. By use of this invention one obtains components of both horizontal and vertical linear polarization, thereby providing antenna coverage to ground stations having linear polarization receiving equipment regardless of the attitude of the vehicle. Moreover, the relative phasing is fixed by mechanical design and is less subject to malfunction during flight.

In the depicted embodiments, which are merely illustrative of the invention, the waveguide structure is shown with a substantially rectangular cross-section. It will be appreciated that such a cross-section may be modified, for example, to conform with a slightly flared or bowed nose cone configuration without departure from the basic teaching of this invention. Likewise, it is understood that the antenna of this invention may be fed, if desired, via means disposed outside the closed ring structure rather than by means disposed inside the closed ring configuration as shown in FIG. 3.

Finally, it is understood that this invention is only to be limited by the scope of the claims appended hereto.

What is claimed is:

1. A microwave antenna of the type having a directional radiation pattern at a selected operating frequency for use on airborne vehicles comprising a hollow waveguide structure having a closed ring configuration with a selected axis of rotation and with a mean circumference substantially equal to twice the wavelength at said operating frequency, said ring configuration having a substantially uniform cross section with at least first and second substantially parallel sides, said first and second sides being a part of the inner and outer surface of revolution of said ring configuration, respectively, antenna feed means disposed within a first selected segment of said structure and adapted for electromagnetic wave energy conversion, said antenna feed means including an outer conductor electrically connected to said inner surface and an inner conductor electrically connected to said outer surface, said structure including first and second wave energy ports disposed in said outer surface of revolution in diametrically opposite relation outside said first selected segment of said structure.

2. The device as claimed in claim 1 wherein said first and second wave energy ports are of the crossed slot variety.

3. The device as claimed in claim 2 wherein each of said first and second wave energy ports comprises a longitudinal slot and a transverse slot.

4. The device as claimed in claim 3 wherein said longitudinal slot and said transverse slot are in substantially perpendicular relation.

5. The device as claimed in claim 1 wherein said vehicle has a tapered conical end-section and said antenna is disposed within said end-section with said outer surface of revolution aligned with the external surface of said end-section.

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