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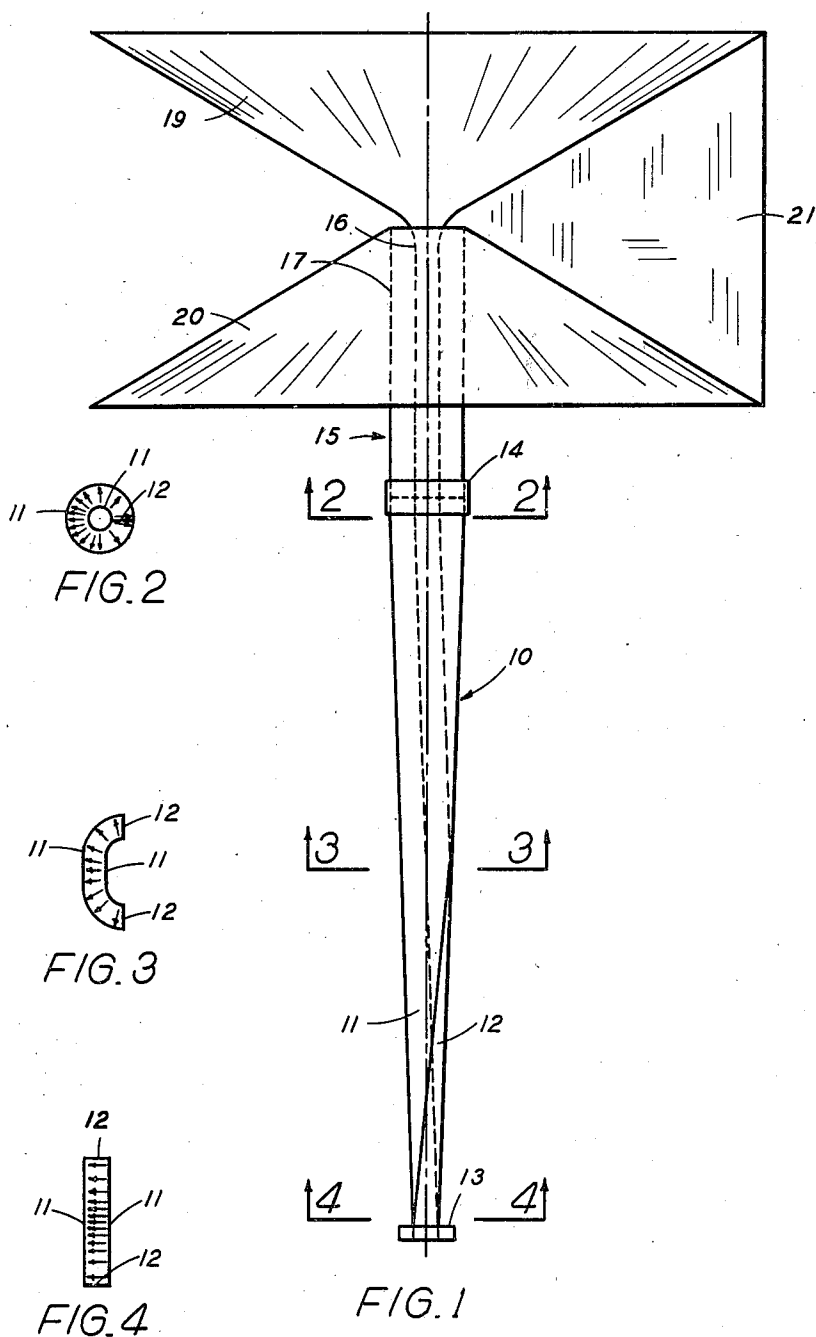
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ANTENNA SYSTEM

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2 Sheets-Sheet 1



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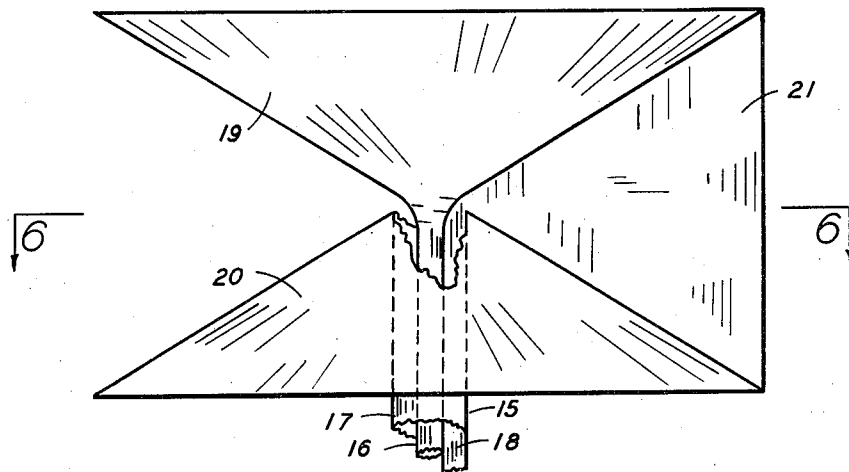


FIG. 5

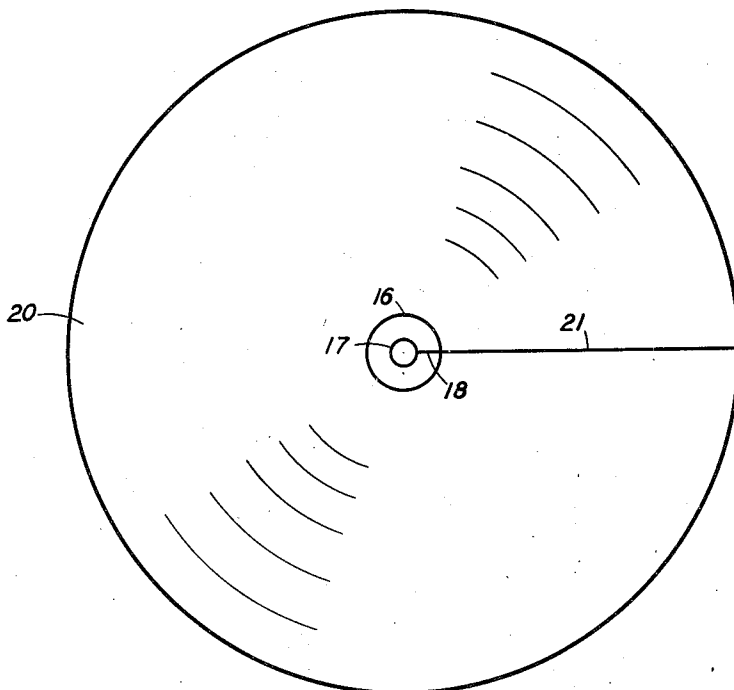


FIG. 6

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ANTENNA SYSTEM

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The present invention relates generally to electrical apparatus and more particularly to an antenna system for use at relatively high operating frequencies.

Whenever electrical apparatus operates at radio frequencies, there exists the problem of impedance matching between adjacent interconnected parts of the apparatus. This problem becomes critical when such apparatus is operated at the higher frequencies of the radio frequency spectrum. Two components of apparatus may readily be designed to have the proper characteristic impedances for impedance matching, but the problem still exists of physically connecting two such components without introducing serious electrical discontinuities arising from the differences in physical dimensions and configurations of the two components. A specific instance of this problem to which the present invention relates is that of connecting an antenna, the shape of which is determined by its radiation pattern and the band of operating frequencies, to a wave guide for transmitting energy between the antenna and its associated receiver or transmitter without introducing electrical discontinuities which result in inefficient power transfer capabilities.

It is an object of the present invention to provide an antenna for the transmission or reception of radio frequency energy over a broad band of relatively high operating frequencies.

It is a further object of this invention to provide an antenna for use with a wave guide wherein the electrical and physical transition between the wave guide and the antenna is accomplished without introducing electrical discontinuities.

It is also an object of this invention to provide a vertically polarized broad beam antenna for operation over a wide band of operating frequencies.

In general this invention comprises an antenna wave guide combination having three principal sections: a transition section, a circular throat section, and a biconical antenna section. The transition section consists of a portion of a rectangular wave guide folded at one end about its longitudinal axis to form the two wide sides of the wave guide into two concentric circles and the two short sides into a septum dividing the annular space between the two long sides. The throat section is used to connect the folded end of the wave guide to the third main section.

Other objects, features, and advantages of this invention will suggest themselves to those skilled in the art and will become apparent from the

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following description of the invention taken in connection with the accompanying drawings in which:

Fig. 1 is an elevation of the assembled components of a preferred embodiment of this invention;

Fig. 2 is a sectional view taken at section 2—2 of Fig. 1;

Fig. 3 is a sectional view taken at section 3—3 of Fig. 1;

Fig. 4 is a sectional view taken at section 4—4 of Fig. 1;

Fig. 5 is a view of the biconical antenna element having a portion thereof cut away; and

Fig. 6 is a sectional view taken at section 6—6 of Fig. 5.

Referring now to Fig. 1, a transition section 10 is formed from a section of conventional rectangular wave guide by gradually bending the long sides 11—11 of the wave guide around the longitudinal axis of the wave guide so that at the top, as shown in Fig. 2, wide sides 11—11 of the wave guide form two concentric circles separated by a septum formed by narrow sides 12—12. Since the amount of bending of wide sides 11—11 is gradual, along the length of wave guide 10, narrow sides 12—12 are farther and farther apart as the distance from the top of wave guide 10 is increased. Thus at an intermediate portion, as shown for example in Fig. 3, the cross-section of wave guide 10 approaches a semi-circular shape. At the lower extremity of wave guide 10 there is no bending so it retains its rectangular cross-section as shown in Fig. 4.

A flange 13 of conventional design is provided at the lower end of transition section 10 to connect that section to the wave guide associated with the receiving or transmitting apparatus. A coupling 14 is provided to connect transition section 10 to throat section 15.

Throat section 15 is of circular cross-section and comprises an inner wall 16 and outer wall 17 which represent extensions of sides 11—11 of wave guide 10. Between the inner wall 16 and outer wall 17 there is disposed a septum 18 which extends the entire length of section 15 and which is a continuation of the septum formed by sides 12—12 of wave guide 10 as may be seen in Fig. 5.

Again referring to Fig. 1, and to Figs. 5 and 6, the upper end of throat section 15 terminates in the antenna proper which consists of two truncated hollow cones 19 and 20. The apex of upper cone 19 is connected to inner wall 16 of throat section 15 and may be formed integral therewith

by flaring the inner wall 16. Lower cone 20 is connected to outer wall 17 of section 15 and may be formed integral therewith by flaring and bending backward outer wall 17. A generally triangular section 21 is fitted between cones 19 and 20 and extends from their apexes to their bases to form a septum which is a continuation and extension of the septum 18 of throat section 15. While the antenna herein described will operate with a minimum of reflections and other electrical discontinuities either as a receiving antenna or as a transmitting antenna, for the purpose of explanation the following discussion of the manner of operation will be limited to that of a transmitting antenna when energy is fed by means of a conventional wave guide connected to flange 13. The arrows on Figs. 2, 3, and 4 represent the field distribution in the respective parts of transition section 10 for the assumed electrical mode of operation.

When energy is being transmitted through a wave guide in the particular mode, known in the art as the H_{01} mode, it will enter the lower portion of transition section 10 with no change in the mode of energy transmission and the conventional field distribution will be as represented by the arrows on Fig. 4. As energy passes along section 10, the field distribution, as shown by the arrows on Fig. 3, remains unchanged although the physical configuration of section 10 is altered. Finally at the upper end of section 10, as shown by the arrows on Fig. 2, the physical configuration of the section 10 has become annular but the H_{01} mode is still retained. Thus there has been a gradual transition from a rectangular wave guide to an annular wave guide with no alteration of the mode of energy transmission. This mode is continued through throat section 15 which is of the same cross-section as the upper end of section 10.

The function of the septa formed by 18 and 21 is to preserve the H_{01} mode throughout throat section 15 and antenna cones 19 and 20.

Consequently, it is evident that the transfer of energy between the antenna and its associated wave guide is made without introducing any electrical discontinuities and it is to be understood that this invention will operate equally effective when used for a receiving antenna.

The particular arrangement disclosed herein of a biconical antenna employing a septum propagates a vertically polarized field and is generally nondirectional in the horizontal plane. By turning the whole system so that the axis of transition section 10 is in a horizontal plane, horizontal polarization may be effected and the antenna is generally nondirectional in the vertical plane. While the system may be described as generally nondirectional, its propagation pattern has a single null in the horizontal plane due to the presence of the septum. In practice vertically polarized antennas constructed in accordance with the principles of this invention have been found to have a pattern approximately 235° wide in the horizontal plane at the 10-decibel-down points and about 60° wide at the 3-decibel-down points in the vertical plane. This, however, varies several degrees as frequency of operation is shifted.

It is well known that conical antennas have inherently low Q characteristics permitting operation over a wide band of frequencies. The present invention discloses an arrangement of connecting such antennas to associated apparatus and thus retaining the advantages of a

conical antenna which overcomes the disadvantages present in previous methods of making such connections.

While there has been here described what is at present considered to be the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention.

What is claimed is:

1. In an antenna system including an antenna and a waveguide for transmitting energy between said antenna and its associated apparatus, a waveguide of rectangular cross-section at the end that is connected to said associated apparatus and having two wide walls and two narrow walls, said waveguide formed by gradually bending said wide walls along the length and around the axis of said waveguide so that at the antenna end of said waveguide one of said wide walls forms an inner wall and the other of said wide walls forms the outer wall of an annular waveguide bounded by concentric circular walls and the narrow walls are in contact and form a radial septum extending from said inner wall to said outer wall, said antenna comprising two cones arranged on the same axis with their apexes adjacent, one of said apexes being connected to said inner wall of the waveguide and the other apex being connected to said outer wall of the waveguide, and a radial septum extending between the sides of said cones from their apexes to their bases and angularly registering with the radial septum in said waveguide whereby energy is transmitted between said antenna and its associated apparatus without electrical discontinuity and without change in electrical mode.

2. In a transmission system for radio frequency energy, a waveguide of rectangular cross-section at one end with two wide walls and two narrow walls, and of annular cross-section at the other end, at which other end the inner wall is formed by one of said wide walls and the outer wall is formed of the other of said wide walls and the two narrow walls form a radial septum, the change from the cross-section at one end to that of the other end being gradual along the length of said waveguide whereby the transmission of energy is accomplished along said waveguide without any electrical discontinuity and without any change in the electrical mode.

3. In a transmission system for radio frequency energy, the combination of a biconical antenna and a rectangular waveguide, said rectangular waveguide being bent gradually along its length and around its axis to form a concentric circular waveguide in which the inner wall is formed by one of the wide walls of the rectangular waveguide and the outer wall is formed by the other wide wall of said waveguide, said waveguide being connected at its circular end to said biconical antenna by attaching the inner wall to one apex of said antenna and the outer wall to the other apex.

4. A radio frequency system comprising a biconical antenna and a transmission line electrically continuous therewith, said transmission line at the point of electrical connection with said biconical antenna comprising a coaxial conductor, said transmission line at a point remote from said point of connection comprising a rectangular wave guide wherein two opposing sides thereof are continuous with the inner and outer conductors of said coaxial transmission line.

5. The system according to claim 4 wherein

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said coaxial conductor and said antenna include means to maintain an identical mode of electromagnetic energy throughout said system.

6. The device according to claim 5 wherein said mode maintaining means includes a radial septum that is continuous with the other two opposing sides of said rectangular wave guide.

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