April 14, 1953 L. C. VAN ATTA 2,635,189

WAVE GUIDE ANTENNA WITH BISECTIONAL RADIATOR

Filed Sept. 14, 1945 2 SHEETS—SHEET 1

FIG.2

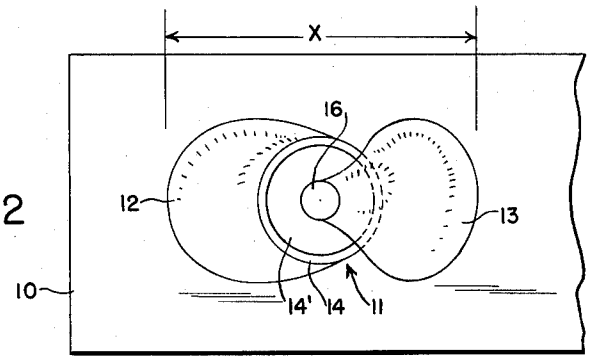


FIG.1

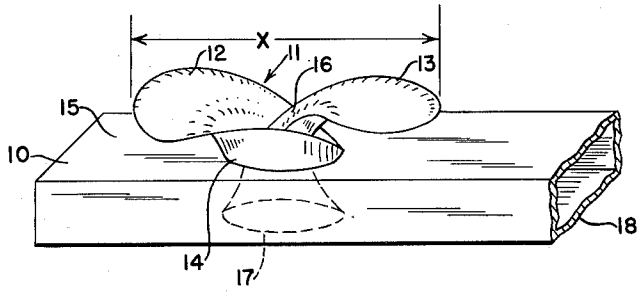
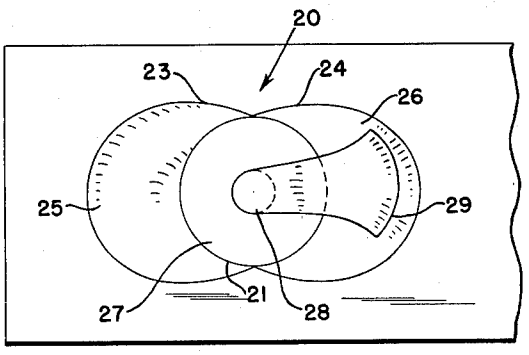


FIG.4



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FIG. 3

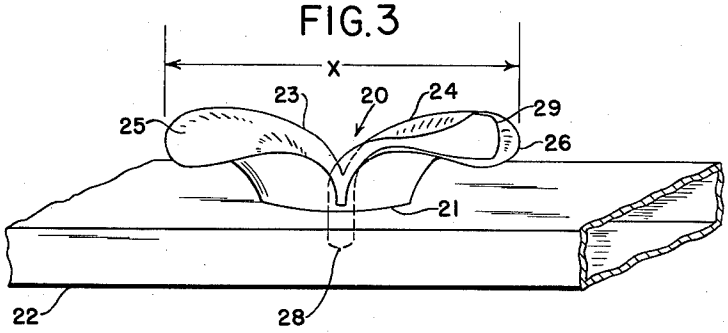


FIG. 5

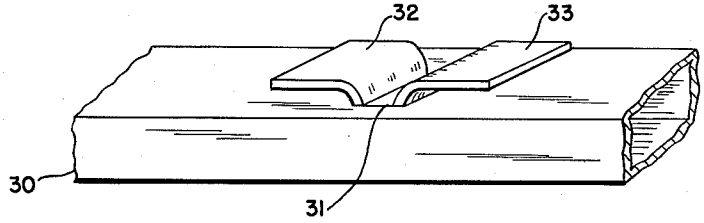
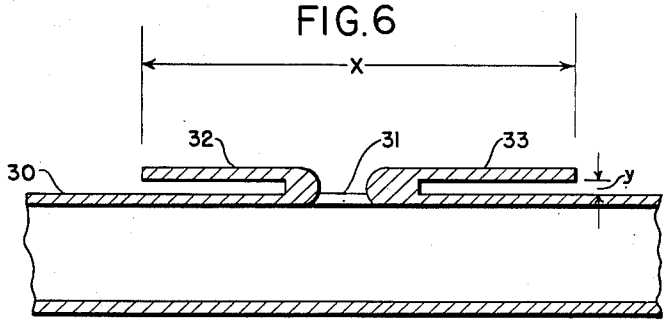


FIG. 6



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UNITED STATES PATENT OFFICE

2,635,189

WAVE GUIDE ANTENNA WITH BISECTIONAL RADIATOR

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7 Claims. (Cl. 250—33.63)

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This invention relates to antennas for high frequency communication systems and particularly to radiating elements of the slot or dipole type fed by an enclosed transmission line such as a hollow pipe wave guide or coaxial conductor.

It is the principal object of this invention to provide a novel radiating element adapted to radiate electromagnetic waves of energy with higher powers and over a greater bandwidth than heretofore obtainable with the conventional slot radiators or conventional dipole radiator.

It is another object of the invention to provide a novel radiating element of smoothly curved conformation adapted to eliminate discontinuities, corners and critical dimensions, which disadvantages are inherent in dipole or slot radiators as heretofore known.

For a better understanding of the invention together with other and further objects thereof, reference is had to the following description, taken in connection with the accompanying drawings.

In the drawings:

Fig. 1 is a perspective view of a novel antenna radiating element of the dipole type according to one embodiment of the invention;

Fig. 2 is a top plan view of the radiating element of Fig. 1;

Fig. 3 is a perspective view of a dipole type radiating element showing a modification according to the present invention;

Fig. 4 is a top plan view of the radiating element of Fig. 3;

Fig. 5 is a perspective view of a slot type radiating element according to further embodiment of the present invention; and

Fig. 6 is a longitudinal sectional view of the radiating element of Fig. 5.

Referring now to Figs. 1 and 2, 10 designates a wave guide generally of rectangular cross-section adapted to transmit energy in the suitable modes from a source not shown. A novel radiating element according to this invention is generally designated 11 and comprises two sections of a dipole, these sections being indicated by 12 and 13. Section 12 comprises a gradually flared leaf-like member having a circular base 14 connected to and mounted on one of the broad walls 15 of wave guide 10. Circular base portion 14 has an aperture 14' therethrough corresponding to an opening in wall 15 for receiving and permitting passage of the neck or stem portion 16 of the radiating element 13.

Radiating element 13 is also leaf-shaped and has a neck or stem portion 16 extending through

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aperture 14' in circular base portion 14 of element 12 and terminating in an enlarged base portion 17, is connected to and in contact with the inner surface of broad wall 18 of wave guide 10 opposite to broad wall 15.

The broad leaf-like portions of elements 12 and 13 have their planes generally parallel to the broad wall 15 of wave guide 10 and are disposed in opposite directions longitudinally of wave guide 10. The distance x between the extreme edge portions of elements 12 and 13 is preferably approximately one-half the wavelength or more of the radiant energy at the desired frequency of operation and the height of the broad leaf-like portions of each of elements 12 and 13 above wave guide 10 is preferably a quarter wavelength, or less, which permits the wave guide 10 to serve as a reflecting surface for the dipole radiating elements 12 and 13. The gradual change of form and dimension of radiating elements 12 and 13 serves to increase both the power handling capacity and the band width of the power radiating element 11. The base portion 17 of element 13 picks up energy propagated within wave guide 10 which is carried through the neck portion 16 into the broad leaf-like portions of element 13. It will thus be seen that radiating element 11 comprises a uniform and gradually flared dipole center fed from opposite walls of wave guide 10 by means of base portions 14 and 17. Base portion 17 may, if desired, be shaped in the standard door-knob type of coupler.

The dipole radiating element 20 as shown in Figs. 3 and 4 is similar to that shown in Fig. 1. Dipole radiating element 20 comprises a substantially circular base 21 mounted on and connected to one of the broad walls of wave guide 22. From the circular base 21 there extend upwardly two flaring leaf-like dipole sections 23 and 24 of uniform and gradual conformation extending in opposite directions from the approximate periphery of base portion 21 so that the broad leaf-like end portions 25 and 26 have their planes substantially parallel with the broad wall of wave guide 22.

Extending through aperture 27 in the base portion 21 through a corresponding opening in the wall of said wave guide and into the region of propagation within wave guide 22 is a probe 28 of any desired and suitable design adapted to pick up energy propagated within wave guide 22. Probe 28 extends upwardly through the base portion 21 and curves smoothly to open through a flared end portion 29 near the edge of leaf-like

portion 26. The flared end portion 29 serves to feed energy to the leaf-like portion 26 and thus to excite the dipole radiating element 20.

The diameter of the circular base portion 21 is preferably approximately one- to two-tenths of the wavelength of the energy at the desired frequency of operation and the dimension x between the extremities of portions 25 and 26 is approximately one-half wavelength as in the case of Fig. 1. Probe 28 may, if desired, be adjustable as to depth of penetration into waveguide 22 to control the power output to radiating dipole element 20. The height of dipole radiating elements 23 and 24 above wave guide 22 is approximately one quarter wavelength so that the wave guide 22 may serve as a reflecting surface for the dipole radiating element 20.

In Figs. 5 and 6 there is shown a modification of the invention as applied to a slot type radiator. Wave guide 30 of rectangular cross-section is provided in one of its walls with a transversely, including, if desired, a diagonally, arranged slot 31 which may serve as a half wave slot radiator of conventional design. Connected along each of the longitudinal edges of slot 31 are radiating plates 32 and 33 comprising substantially flat sheets of electrically conductive material having their edges along the edges of slot 31 bent so that the planes of plates 32 and 33 are substantially parallel to the broad wall of wave guide 30. Thus, plates 32 and 33 are connected along one of their edges to the opposite edge portions of slot 31 and then bent away from each other so that they are in alignment and their common plane is parallel to the broad wall of wave guide 30. Preferably the distance x between the extreme free edges of plates 32 and 33 is approximately half a wavelength and the distance y between the plates 32 and 33 at their free edges and wave guide 30 is preferably less than a quarter wavelength. In effect, plates 32 and 33 may be dimensioned so that their overall dimensions form a square conducting plane one-half wavelength on edge which is adapted to be excited by the radiation through slot 31 and act as a dipole radiating element.

The radiating elements, as shown and described hereinbefore with reference to the several figures in the drawings, have been capable of having a greater power handling capacity and are effective over a greater band of frequencies than dipole or slot radiating elements heretofore used.

While the invention has been herein described with reference to a rectangular wave guide for feeding energy to the radiating element, it will be understood that the invention is not limited to this particular structure. Instead the radiating elements according to the invention may be mounted on and coupled to a hollow pipe wave guide of any desired cross-section or a coaxial conductor along the length or at the ends thereof.

While there has been described what is at present considered the preferred embodiments 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 invention.

What is claimed is:

1. An antenna for high frequency communication systems including a rectangular hollow pipe wave guide for transmission of waves of electromagnetic energy, a radiating element coupled to the energy in said wave guide, said element comprising two leaf-like sections extending outwardly from one of the walls of said wave guide, said sections being bent away from each other substantially parallel to the longitudinal axis of said wave guide toward opposite ends of said wave guide in such a manner that their planes are in substantial alignment and substantially parallel to said wall of said wave guide.

2. An antenna as claimed in claim 1 wherein the distance between opposite extremities between each section are approximately half the wavelength of the energy at the desired frequency of operation and wherein the distance from each of said extremities to the adjacent wall of said wave guide is no more than a quarter wavelength of said energy.

3. An antenna as claimed in claim 1 in which said element comprises a dipole, one of the dipole sections comprising a substantially circular base having an aperture therein, said base being mounted on one of the broad walls of said wave guide, said one section being leaf-like in shape and extending gradually and uniformly away from said base and said wave guide, the other one of said sections comprising a base connected to the surface of the other broad wall of said wave guide, a neck portion extending to said base through said aperture, and a uniformly and gradually flaring portion connected to the said neck portion, the free ends of said leaf-like portions extending in opposite directions longitudinally of said wave guide with their planes substantially parallel with the broad wall of said wave guide.

4. An antenna as claimed in claim 1 wherein said element comprises a dipole, said two dipole sections comprise a substantially circular base having an aperture therein connected to one of the broad walls of said wave guide and gradually flaring leaf-like portions extending from said base away from said wall and longitudinally away from said wave guide, said wall having an opening therein corresponding to said aperture, and wherein a probe is disposed in a region of propagation in said wave guide, a member connected to said probe and extending through said opening and through said aperture and along the general conformation of one of said dipole sections, said member terminating in a flared end portion adjacent the extremity of one of said sections, said member being adapted to transmit energy picked up by said probe to said one section whereby said radiating element is excited by said energy.

5. An antenna as claimed in claim 1 wherein the wave guide has a radiating slot disposed transversely in one of the walls thereof, and wherein each of said dipole sections comprises substantially rectangular plate members, each plate member being connected along one of their edges to opposite longitudinal edges of said slot.

6. An antenna as claimed in claim 1 wherein said element comprises a dipole, said two dipole sections comprise a substantially circular base having an aperture therein connected to one of the broad walls of said wave guide and gradually flaring leaf-like portions extending from said base away from said wall and longitudinally away from said wave guide, said wall having an opening therein corresponding to said aperture, and wherein a probe is disposed in a region of propagation in said wave guide, a member connected to said probe and extending through said opening and through said aperture and along the general conformation of one of said dipole sections, said member terminating in a flared end portion adjacent the extermity of one of said sections, said member being adapted to transmit energy picked up by said probe to said one section whereby said radiating element is excited by said en-

ergy, and wherein said circular base has a diameter of between one-tenth and two-tenths of a wavelength of said energy at the desired frequency of operation.

7. An antenna as claimed in claim 1 wherein the wave guide has a radiating slot disposed transversely in one of the walls thereof, wherein each of said dipole sections comprises substantially rectangular plate members, each plate member being connected along one of their edges to opposite longitudinal edges of said slot, and wherein said rectangular sections together form a square each of whose edges equals approximately one-half of a wavelength of said energy at the desired frequency of operation.

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