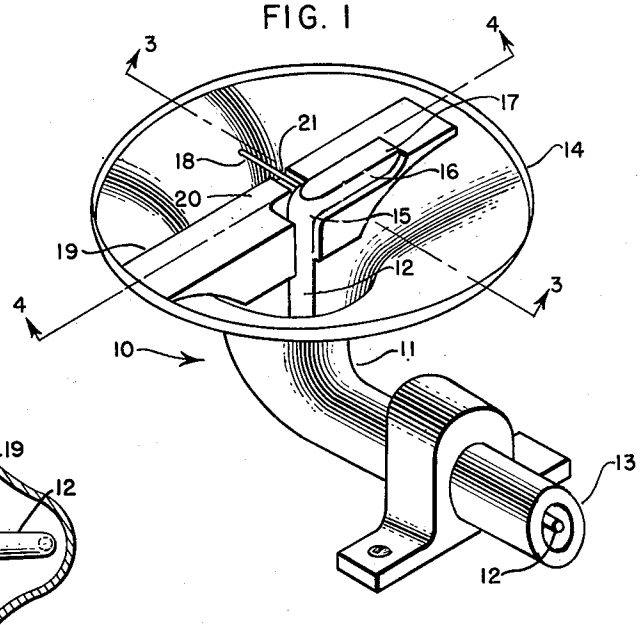
April 14, 1953 H. J. RIBLET ET AL 2,635,190

HORN RADIATOR ADAPTED TO PRODUCE CIRCULARLY POLARIZED WAVES

Filed May 24, 1946

FIG. 1



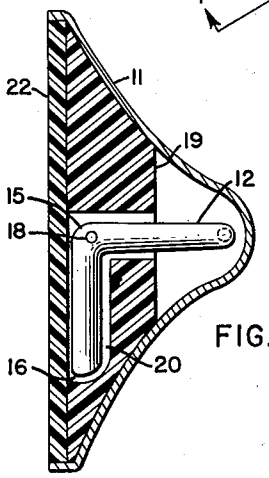
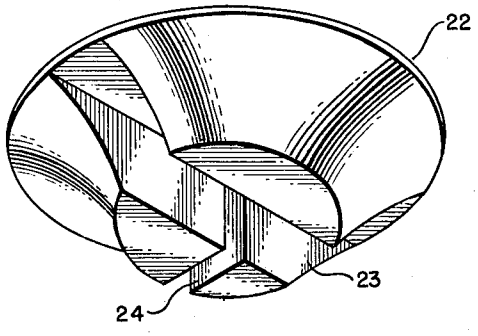


FIG. 4

FIG. 2



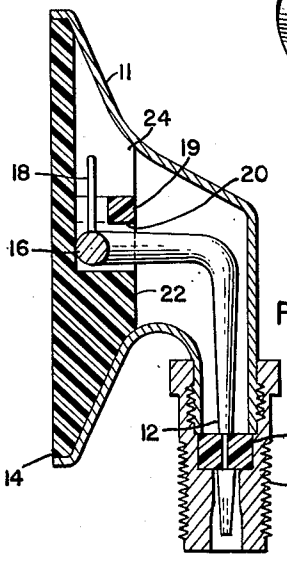


FIG. 3

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HORN RADIATOR ADAPTED TO PRODUCE CIRCULARLY POLARIZED WAVES

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4 Claims. (Cl. 250—33.63)

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This invention relates to devices for radiating waves of electromagnetic energy such as used in high frequency communication systems including radio object-locating systems. More particularly the invention is directed to a device for adapting the principles of a flared horn type radiating element directly to the termination of a coaxial conductor transmission line or the like and for producing circularly polarized radiant energy.

A radiating element of the horn type has wide application and can be used to match a waveguide transmission line to free space and thus may be used to radiate waves of electromagnetic energy directly to free space. Another application is in feeding energy to and illuminating a reflector adapted to direct energy into free space in any desired radiation pattern. Heretofore, a horn type radiating element has required a hollow pipe waveguide for feeding energy thereto. In the cases where the energy is transmitted from its source by a coaxial line, it has been necessary to have a coupling device from the coaxial line to a hollow pipe waveguide for feeding the horn. The present invention eliminates the need for a coupling device by terminating a coaxial conductor type transmission line in a flared horn type section.

Accordingly, it is one of the objects of the present invention to provide a flared termination to a coaxial conductor line whereby energy may be radiated directly therefrom.

It is another object of the invention to provide a horn type termination to a coaxial transmission line and in which the inner conductor is disposed in such a manner that it is effective as a dipole section, the orientation of the dipole section determining the plane of polarization of the radiant energy.

It is still another object of the invention to provide a coaxial horn antenna with means whereby circular polarization of the radiant energy is afforded (polarization being defined in the sense used in the radio art rather than in the official sense and referring here to the direction of the electric vector rather than that of the magnetic vector).

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

Fig. 1 is a perspective view of a coaxial horn antenna according to the present invention;

Fig. 2 is a perspective view of a weatherizing structure adapted to fit the horn of Fig. 1; and

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Figs. 3 and 4 are sectional views taken along the lines of 3—3 and 4—4 of Fig. 2, respectively.

Referring to Figs. 1, 3 and 4, there is shown a flared horn structure 10 having an outer flared conductor 11 and an inner conductor 12 adapted to be connected at the throat portion 13 to a coaxial conductor transmission line. Any suitable means may be provided for making the connection, for example, the outer surface of the throat portion 13 may be threaded to provide threaded engagement to the outer conductor of the coaxial transmission line or a suitable coupling member 13' may be provided. The end of the inner conductor 12 of the horn at the throat 13 may have a sliding fit with or any other suitable coupling to the inner conductor of the coaxial transmission line. From the throat portion 13, the outer conductor 11 is flared out in a relatively smooth manner to provide a circular mouth termination 14, preferably the flared portion 11 is bent or curved smoothly so that the plane of the aperture of the mouth 14 is substantially parallel to the axis of the throat portion 13. The inner conductor 12 is bent to follow the approximate axis of the flared portion 11 until close to the aperture plane and then bent substantially at a right angle as at 15 so that the bent end portion 16 is substantially parallel to the plane of the mouth 14. The free end 17 of inner conductor 12 may, if desired, actually touch the periphery of the circular mouth 14 although as shown it is preferred that there be a slight spacing between the peripheral mouth portion and the end 17 of the inner conductor 12. Adjacent the right angle bend 15 of inner conductor 12 is a relatively short rod, bar or strip member 18 mounted perpendicularly to the axis of bent end portion 16, the axis of the short rod member 18 also lying parallel to the aperture plane of the mouth 14.

The bent end portion 16 acts in cooperation with the flared outer conductor 11 to provide in effect a dipole radiating element, which is resonant at the operating frequency, the orientation of the bent portion 16 determining the plane of polarization of the radiant energy. Thus when the bent portion 16 is disposed in a vertical or horizontal manner, vertical or horizontal polarization of the radiant energy respectively results. The addition to the member 18 converts the plane polarized energy to a circularly polarized one. It is noted that the member 18 is shorter and of a smaller cross-sectional dimension than the main radiating element comprising the bent end portion 16. Because of these differences, the current which flows in member 16 is essentially

90° in time phase with the current which flows in member 18. Since the members 16 and 18 are also oriented at 90° with each other in space phase the necessary relationships exist to produce circularly polarized energy.

In order to provide additional support to the inner conductor member 11 and the end portion 16, a supporting member 19 may be inserted in the flared portion of the horn in a generally diametrical manner. This supporting member 19 may be a suitably shaped strip of dielectric material and is provided with recesses or slots 20 and 21 for accommodating inner conductor 12 with its bent end portion 16 and member 18 respectively. To prevent the effect of changes in weather and pressure, the horn may be closed and sealed by means of the weatherizing member 22 as shown in Fig. 2 which is shaped to fit within the mouth 14 of the flared horn portion and is provided with recesses, slots or grooves 23 and 24 for receiving the supporting member 19 and to provide clearance for the member 18 respectively. The slot 24 should be carefully dimensioned as the size thereof may affect the radiation from member 18.

It has been found that an antenna comprising the flared horn termination to a coaxial transmission line such as described hereinbefore has produced extremely satisfactory results in affording circular polarization over a broad band of frequencies.

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

What is claimed is:

1. A device for radiating circularly polarized waves of electromagnetic energy adapted to be connected directly to a coaxial conductor transmission line comprising an outer conductor in the shape of a smoothly flaring horn having a throat portion adapted to be connected to the outer conductor of said coaxial line and a portion flaring smoothly and evenly outwardly on all sides from said throat portion with its end defining a substantially circular aperture, an inner conductor located substantially centrally within said outer conductor, one end of said inner conductor being adapted to be connected to the central conductor of said coaxial line, the opposite end portion of said inner conductor being bent toward the end of said flaring portion defining said aperture, said bent end portion being substantially in the plane of said circular aperture, and a substantially straight member connected to said bent end portion adjacent the point of bending thereof, said member extending outwardly substantially at a right angle from said bent end portion substantially in the plane of said circular aperture, whereby said bent end portion and said member are oriented at 90° with each other in space phase, said member being of smaller cross-section and length than said bent end portion whereby the energy currents in said member and said end portion are substantially in 90° time phase when said bent end is resonant at the operating frequency, said device thereby being adapted to radiate circularly polarized energy at said operating frequency.

2. A horn-shaped radiating element comprising an outer conductor flaring outwardly to form a horn with an outer circular aperture, an inner conductor located substantially centrally of said outer conductor for the major portion of its length, the end of said inner conductor near the aperture of said horn being bent toward the end of said horn to effectively afford a dipole radiating element, said bent end portion being substantially in the plane of said aperture, and a substantially straight member extending from the bent end portion adjacent the bend therein and at substantially 90° to said bent end portion substantially in the plane of said aperture, said member being of smaller cross-section and length than said bent end portion whereby said bent end portion and said member cooperate to radiate circularly polarized energy from said element when properly energized.

3. A device for radiating circularly polarized waves comprising first radiating means in the form of a first straight conductor of a given cross-section and length so as to be resonant at a given frequency, means connected to one end of said first conductor for feeding said first conductor with ultra-high frequency electromagnetic energy of said given frequency, and second radiating means in the form of a second straight conductor connected at one end directly to said one end of said first conductor and oriented perpendicular to said first conductor, said second conductor having a sufficiently smaller cross-section and length than said first conductor so as to be non-resonant at said given frequency, whereby said second conductor is energized in 90° time phase relationship with respect to the energization of said first conductor at said given frequency.

4. A device for radiating circularly polarized energy comprising a first radiator having a given cross-sectional area and resonant at a given frequency, a second radiator having a cross-sectional area substantially smaller than that of said first radiator and non-resonant at said given frequency, means for applying to the inputs of both radiators in phase exciting voltages having said given frequency, and said first radiator being oriented at an angle of substantially 90° with respect to said second radiator.

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