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APPLE-CORE REFLECTOR ANTENNA

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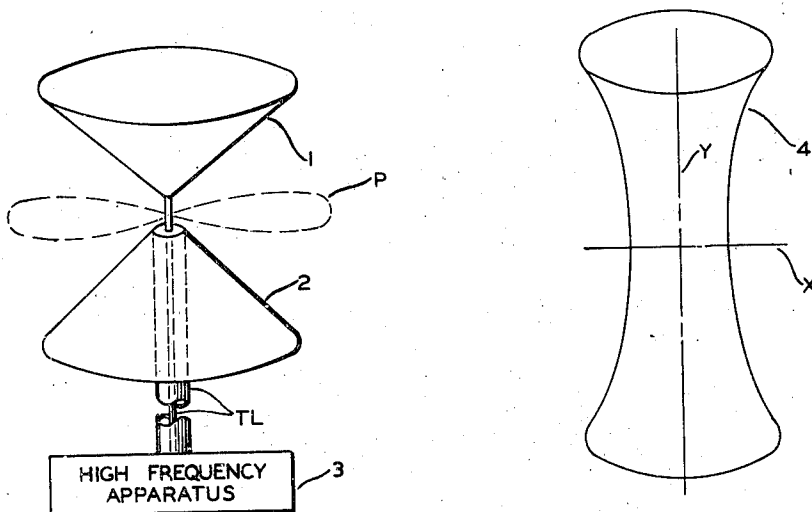


FIG. 1

FIG. 2

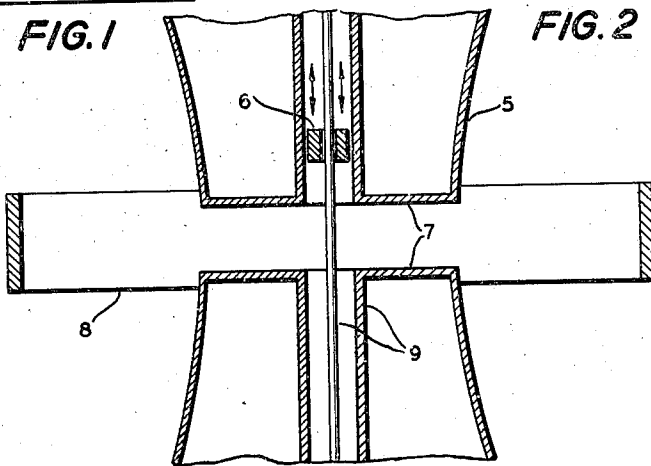


FIG. 3

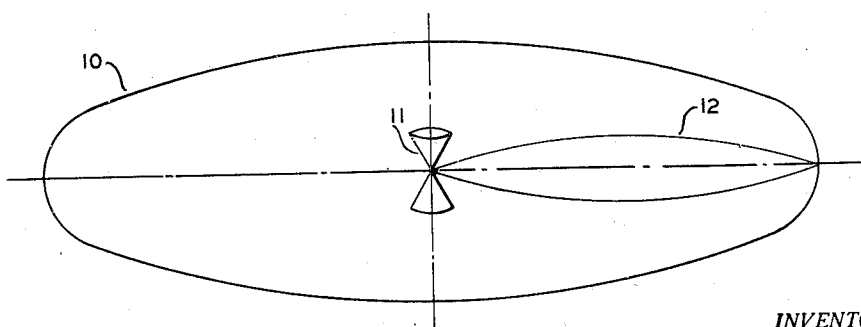


FIG. 4

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APPLE-CORE REFLECTOR ANTENNA

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Navy

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1 Claim. (Cl. 250—33)

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This invention relates in general to antennas and more particularly to antennas designed for use with micro-waves. The device illustrated in this application is produced for use with micro-wave beacons, and it is given the name apple core beacon reflector which is somewhat descriptive of its general structural form.

Fundamentally, applicant's invention is based on the hour glass antenna which consists of two cones so oriented that they have a common vertical axis and whose apices are joined. Reference is made to the Schelkunoff Patent No. 2,235,506, and particularly to Figs. 7 and 8 and the description thereof for a mathematical discussion of the hour glass antenna.

When the cones of this antenna are excited at their adjacent apices by means of a concentric transmission line, their energy radiation pattern is illustrated in Fig. 1 of the Carter Patent No. 2,175,252. From Fig. 1, it will be observed that there is obtained maximum radiation at right angles to the axis of the cones; the pattern being circular at right angles to the drawing and a figure eight in the plane of the drawing.

It has been shown that none of the antennas of the prior art produce a radiation pattern that is thin enough in the vertical plane to give the desired antenna characteristics for use with micro-wave beacons.

It is an object of this invention to provide an antenna suitable for use with micro-wave beacons.

Another object of this invention is to provide an antenna whose energy distribution is vertically thin and of a circular pattern.

Another object of this invention is to produce an antenna whose energy distribution is vertically thin and of a circular pattern by the use of special reflecting means.

Another object of this invention is the provision of an antenna system which will be economical to manufacture, reliable in operation and which possesses all of the qualities of ruggedness and dependability in service.

Other objects and features will become apparent upon a careful consideration of the following detailed description when taken together with the accompanying drawings, the figures of which are designed for the sole purpose of illustration and not as a definition of the limits of the invention, reference for the latter purpose being had to the appended claims.

In the drawings:

Fig. 1 is an illustration of the prior art,

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Fig. 2 is an illustration of the reflecting surface of this invention.

Fig. 3 is a cross section through the center of the antenna.

Fig. 4 is an illustration of the energy radiation pattern of the antenna of this invention.

Before going into a discussion of this invention it is believed that it will be helpful to an understanding thereof to point out the prior art as set forth in the Carter Patent No. 2,175,252 and illustrated in Fig. 1 of the drawings of this application.

Referring to Fig. 1, there is shown an hour glass type of antenna comprising two conducting surfaces of revolution in the form of hollow cones 1 and 2 symmetrically arranged about a vertical axis, the apices being placed adjacent each other. The cones are excited at their adjacent apices by means of a concentric transmission line TL which extends from a remotely located transmitter 3, usually five or more wave lengths away from the antenna, the inner conductor being connected to the apex of one of the cones, for example the upper cone 1, as shown, while the outer conductor is connected to the other cone 2.

The energy radiation pattern obtained by the system of Fig. 1 is indicated in the dotted lines by P, which it will be noted is similar to that of a half wave dipole. It will be observed that there is obtained maximum radiation at right angles to the axis of the cone; the pattern being circular at right angles to the drawing, and a figure eight in the plane of the drawing.

Referring to Fig. 2, there is shown the surface contour of the antenna of this invention. To describe it geometrically, the apple core reflector is a surface generated by rotating a parabola $y^2=4px$ around the Y axis or a line parallel to the Y axis not intersecting the parabola. In the plane of the drawing this parabolic line has a focal point on the X axis. In considering Fig. 2 the parabolic surface of revolution has a focal ring, composed of the focal points, encircling it in the plane of the smallest circular section of the reflector which in the case of Fig. 2 is the plane of the X axis.

Referring to Fig. 3, there is shown a partial cross section of the antenna, and in particular the part near the center thereof. There are various ways of coupling into the apple core reflector, in general each coupling depends upon the system from which the reflector is fed; for example, a wave guide system may be used or a coaxial transmission line system. Also, the coupling will depend upon whether horizontal or vertical polarization is desired.

Since it is desirable to have a symmetrical energy radiation pattern, in certain instances, a coaxial transmission line is used to couple the antenna to the transmitter in this illustration; because when connected to the center of the antenna system as shown the resulting energy radiation pattern will be symmetrical about a plane passing through the smallest circular section of the reflector. A small gap is formed in the parabolic surface at the plane of smallest circular section by cutting away portions thereof and attaching end plates 7, which in turn are attached near their center to the outer conductor of the coaxial cable 9. The outer conductor of the coaxial cable is eliminated within the above mentioned gap while the center conductor passes through it. The electromagnetic radiation passes out of the gap and impinges upon a reflecting ring 8 which in turn directs the radiation against the surface of the reflector.

Theoretically, if the radiation could be made to emanate from an infinite number of evenly spaced point sources in the focal line, and if the aperture of the antenna (in this case, its length) were infinite, the pattern of distribution in the vertical plane should be that of a parallel beam. However, practically these theoretical conditions can never be attained. The aperture is finite compared with the wavelength and the radiating source cannot be a single-line ring. Reflecting ring 8 is therefore so designed to give a pattern of minimum thickness but must be wide enough (vertically) to intercept ample energy from the gap which requires a width approaching one-half wavelength when vertical polarization is employed as in the drawing. When horizontal polarization is employed, it need not be as wide.

An apple core reflecting antenna made in accordance with this disclosure will give an energy radiation pattern approximately as illustrated in Fig. 4. Where 11 is the apple core reflector, emanating a pattern 10 of a minimum thickness 12. Actually, diffraction will cause a certain portion of the energy to exist in side-lobes but these may be minimized by increasing the aperture.

Tuning means are provided in the antenna of this invention and illustrated at 6 in Fig. 3. The device 6 may be moved up or down the section of coaxial line as indicated by the arrows to give the degree of tuning desired. Although not shown in the figure it is possible to improve the tuning of the system to balance out the reactance of the feed by employing any one of a number of conventional adjustable impedance tuners in the wave guide or coaxial line system supplying energy to the antenna.

I claim:

A short wave antenna comprising in combination, a parabolic surface of revolution symmetrically located with respect to the vertical axis of the antenna, said surface of revolution having a slot of predetermined axial dimension, the opposed circular edges of said slot being symmetrically disposed with respect to the plane of smallest circular section of said surface of revolution, a coaxial cable feed coaxial with the axis of said antenna, the outer conductor of said coaxial cable having an outer diameter substantially less than the diameter of said surface of revolution in the aforesaid plane of smallest circular section, said outer conductor having a cylindrical opening of axial dimension equal to the aforesaid predetermined axial dimension of said slot in said surface of revolution, a pair of annular plates conductively connecting the edges of said cylindrical opening in said outer conductor to said opposed circular edges of said slot in said surface of revolution thereby providing a passage for the transfer of energy from said coaxial cable feed to said surface of revolution, the inner conductor of said coaxial cable extending through said outer conductor and across said cylindrical opening therein, a tuning plunger operative axially within said coaxial cable on one side of said cylindrical opening, a cylindrical conductive ring coaxial with said antenna of axial dimension less than one-half wavelength measured at the operating frequency of said antenna, said ring being disposed symmetrically with respect to said antenna and including the focal line of said surface of revolution, said ring being adapted to reflect energy flowing between said surface of revolution and said passage, the overall radiation pattern of said antenna being of substantially pancake formation.

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The following references are of record in the file of this patent:

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