Nov. 14, 1950 L. C. VAN ATTA 2,530,098

ANTENNA

Filed May 3, 1945

FIG. 1

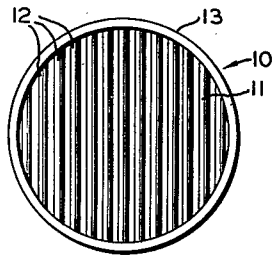


FIG. 2

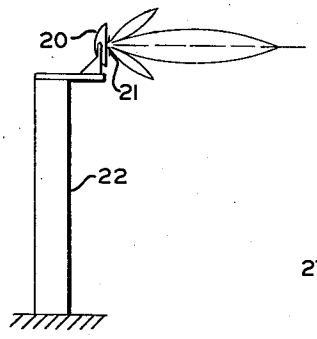


FIG. 3

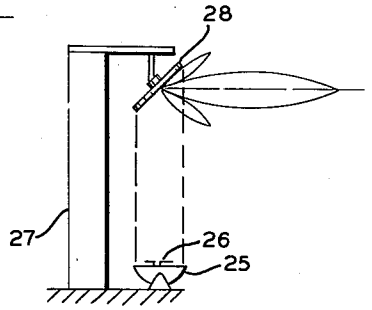


FIG. 4

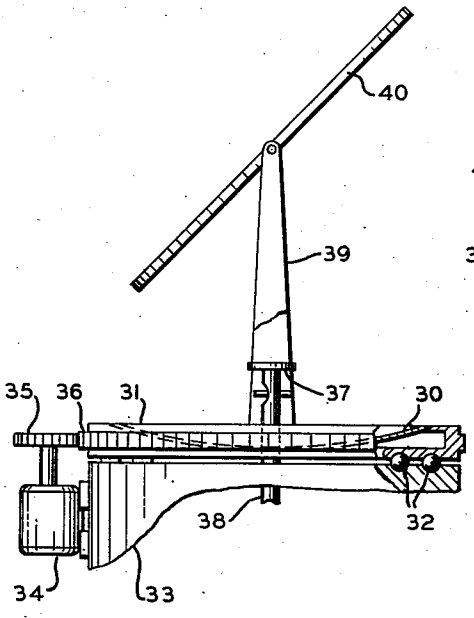
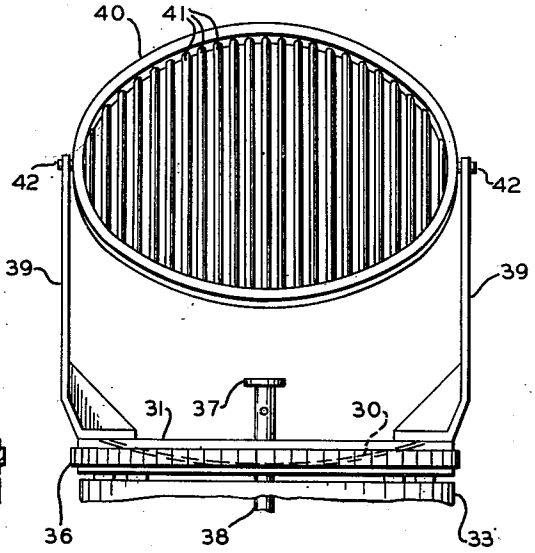


FIG. 5



INVENTOR.

LESTER C. VAN ATTA

BY

William D. Hall.

ATTORNEY

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ANTENNA

Lester C. Van Atta, Winchester, Mass., assignor, by mesne assignments, to the United States of America as represented by the Secretary of War

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1 Claim. (Cl. 250—33.65)

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This invention relates to antennas for use in high frequency communication systems. It is particularly adapted to antenna systems incorporating radiating elements and reflecting surfaces such as dipoles and parabolic reflectors.

While a smooth, continuous metallic surface is the simplest and usually the best form of microwave reflector from the standpoint of efficient reflection, there are several applications for which some sacrifice of reflector efficiency is justified and for which a partially open reflector in the form of a grating, screen or perforated sheet, according to this invention, will have advantages. Such advantages include:

(1) Reduced wind resistance;
(2) Reduced weight/strength factor;
(3) Increased ease of fabrication and assembly;
(4) Visual transparency; and
(5) Adjustability of reflector shape.

It is one of the objects of the present invention to provide an antenna having a partially open reflector particularly a grating type reflector.

It is another object of the invention to provide an antenna having a reflector whose characteristics are low wind resistance and lightness.

Another object of the invention is to provide an antenna having a parabolic reflector, a radiating element for illuminating the same, and an auxiliary partially open reflector for directing the energy reflected by the parabolic reflector in a divergent path.

Other novel features and advantages of the invention will become apparent as the description proceeds.

In the drawings:

Fig. 1 is a diagrammatic front elevational view of a partially open reflector according to the invention;

Fig. 2 is a diagrammatic side elevation of an antenna having a reflector according to one embodiment of the invention and the mounting for such antenna;

Fig. 3 is a diagrammatic side elevation of an antenna having a different reflector arrangement according to another embodiment of the invention;

Figs. 4 and 5 are side and front elevations illustrating still another embodiment of the reflector according to the invention.

In most communication systems, including radio object-locating systems, it is desirable that the antenna or at least the means for directing the energy is located sufficiently high for good

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range and well above ground or other obstructions for clearest azimuthal view. A mast mounting for the antenna satisfies both conditions on land or on ships. In antennas, particularly those mounted high above the ground or ship's deck, an important factor is the wind resistance and lightness of the reflector. As mentioned hereinbefore a partially open reflector is characterized by having the advantages set forth. The following description illustrates by way of example several applications of a partially open reflector according to this invention.

Referring now to Fig. 1, there is shown a reflector 10 for an antenna. Reflector 10 may have a reflecting surface 11 formed as a flat plane member or as a parabolic, hyperbolic or any other suitably shaped surface. The front view configuration of reflector 10 may be circular, elliptical, rectangular or of any suitable shape.

In conventional antenna systems embodying a reflector it is well known to form the reflecting surface of a thin conducting sheet of metal or other suitable electrically conductive material. However, according to this invention reflector 10 is formed as a partially open reflector, at least a portion of the reflecting surface being in the form of a grating, screen or perforated sheet. For the present description the reflecting surface 11 is shown as preferably being in the form of a grating. Reflecting surface 11, or at least that portion formed as a grating, comprises a plurality of uniformly spaced parallel bars, rods or strips 12, the forward edges of bars 12 defining at least a portion of the reflecting surface 11.

Bars or strips 12 may be of any suitable shape and size. It has been determined that the best results are obtained when, as in a preferred embodiment, bars 12 are formed of extremely thin substantially flat strips of metal or other suitable conducting material arranged with their planes perpendicular to the plane of the reflecting surface 11 which is formed by their longitudinal front edges. Such edgewise strip grating is particularly adaptable to fabrication by means of cutting rather than a forming operation. Also such a grating reduces normal wind resistance by a factor of five or more with negligible sacrifice of reflection efficiency. Another advantage is that mechanical rigidity is quite good with proper bracing. It has been found that round or tubular bars give fairly good results and bars formed of flat strips with their planes lying in the plane of the reflecting surface 11 may also be used.

General considerations are the same for

screens and perforated sheet as for gratings since a screen can be thought of as two gratings at right angles. Screens of round wire are better than those of flat strips provided that intersections are electrically good in both cases. Egg crate construction would be best of all, especially if it were desired to reduce wind resistance to a very low value.

For a flat reflecting surface 11, bars 12 are straight while for a parabolic or other surface having a curvature, bars 12 will be curved in the desired manner so that their forward portions will form the desired shape of the reflecting surface. Bars 12 may be supported and secured to a suitably shaped frame 13 in any desired manner such as by screws, welding, brazing, soldering, etc.

It is desirable that the percent open area of reflector 10 be large relative to the areas of the edges of bars or strips 12. Preferably the space between adjacent bars 12 is less than half the wavelength and slightly greater than a quarter of the wavelength (in air) of the energy directed on reflecting surface 11.

It is also desirable that the longitudinal edges of bars or strips 12 lie in planes substantially parallel to the E-vector of the energy impinging thereon. The E-vector of the primary field impinging upon the reflector is thus oriented to be parallel with the strips, and considering the space between two strips, the energy tending to propagate therethrough will be attenuated according to the attenuation of a wave guide designed "beyond cutoff." The amount of attenuation will be proportional to the depth of the strip and the resultant effect is as if the average reflecting surface of the grating reflector is located slightly back from the surface formed by the front edges of the strips. This arises because of the fact that the energy cannot be immediately attenuated upon reaching this inter-strip region but must be attenuated exponentially, thus resulting in an effective reflecting surface displaced inward a given amount. Bars or strips 12, when associated with a backing reflector, may also be arranged to be in planes perpendicular or at an angle to the E-vector which angular relation may be determined according to the desired polarization characteristics of the reflected energy.

Fig. 2 illustrates one application of the antenna embodying a reflector according to this invention. Reflector 20 is shown as having a paraboloidal reflecting surface formed as a grating in the manner described hereinbefore. Reflector 20 is positioned in a conventional manner to be illuminated by a radiating element such as a dipole feed 21, or a horn, located at the approximate focal point of reflector 20. Dipole feed 21 is fed and excited in a well known manner such as by a wave guide or coaxial line (not shown). Reflector 20 is mounted in any suitable manner on a support such as mast 22 and may be rotated about a substantially vertical axis for azimuthal coverage in a well known manner.

Fig. 3 illustrates another application of the reflector according to this invention. Instead of the radiating element and reflector being mounted near the top of a mast, as illustrated in Fig. 2, a smooth surface paraboloidal reflector 25 illuminated by a radiating element 26 is mounted near the bottom of the mast 27 with its axis substantially perpendicular to the ground plane in such manner that radiant energy is directed vertically upward. An auxiliary reflector 28 is mounted near the top of mast 27 to rotate about a vertical axis substantially coincident with the axis of reflector 25. Auxiliary reflector 28 preferably has a flat reflecting surface formed as a grating in the manner described hereinbefore with reference to Fig. 1. The surface of reflector 28 is arranged at an angle, preferably of 45°, to a plane arranged perpendicularly to the axis of reflector 25, whereby the upwardly directed radiant energy is reflected in a direction substantially perpendicular to the energy impinging on reflector 28. It will be understood that the reflecting surface of auxiliary reflector 28, instead of being flat, may also be of parabolic, hyperbolic or any other desired shape so that it is adapted to reflect energy in a beam pattern of any desired configuration including a pattern in which the energy distribution is a function of the cosecant of the radiation angle measured from the axis of auxiliary reflector 28. Thus reflector 25 serves to focus the beam of radiant energy while auxiliary reflector is adapted to direct the energy along a divergent path and if desired shape the beam of the reflected energy. Also it will be understood that reflector 25 and its radiating element 26 or the radiating element only may be rotated about the reflector axis in any conventional manner, preferably at the same speed of rotation as auxiliary reflector 28.

An arrangement according to Fig. 3 has several advantages. It affords a lighter construction, reduced wind resistance, eliminates long transmission lines and consequent connections, and makes the radiating element and its reflector more accessible for repairs and replacement.

A similar arrangement is illustrated in Figs. 4 and 5. A conventional paraboloidal reflector 30 is suitably supported with its axis preferably perpendicular to the ground plane. Reflector 30 may be mounted to be stationary or it may be mounted to rotate about its axis. Thus for example, reflector 30 may be rigidly or freely supported in a shallow cylindrical frame 31 mounted to be free to rotate on ball or roller bearings 32 carried by a base 33. Any suitable means may be provided for rotating frame 31 such as a motor 34 driving a gear 35 meshing with a ring gear 36 secured around the periphery of frame 31.

Reflector 30 is illuminated in a conventional manner by a radiating element such as dipole and parasitic element 37 fed by a wave guide or coaxial transmission line 38 and mounted at the apparent focal center of reflector 30 to rotate about the reflector axis. Suitably and rigidly mounted on edge portions of frame 31 are upstanding supporting members 39, here shown as two beams of any desired length, mounted on diametrically opposite sides of frame 31.

An auxiliary partially open reflector 40, having a reflecting surface preferably formed by grating bars 41 substantially as hereinbefore described with reference to Fig. 1, is secured and preferably mounted between supporting members 39 such as by shafts, bolts, or lugs 42. The surface of reflector 40 may be flat or suitably shaped to shape the reflected beam as hereinbefore described with reference to Fig. 3. Reflector 40 is arranged so that a plane perpendicular to its axis is at an angle, preferably of 45°, to the latus rectum plane of reflector 30 with the planes of grating bars or strips 41 substantially parallel to the axis of reflector 30 or preferably parallel to the E-vector of the radiant energy.

As will be understood reflector 30 is adapted to direct radiant energy upwardly and with re-

flector **40** set at a 45° angle thereto, the latter will reflect energy in a substantially horizontal direction. In order that reflector **40** may efficiently intercept the incident beam, it is preferable that reflector **40** be substantially elliptical in shape with the major axis substantially coincident with the axis of the supporting shafts **42**.

It will be understood that with the arrangement as described with reference to Figs. 4 and 5 reflector **40** will rotate about the axis of reflector **30** at substantially the same speed of rotation therewith. It will also be understood that reflector **30** need not be rotated but may remain stationary in which case frame **31** is not secured to reflector **30** but is arranged to rotate relative thereto. However, in order to maintain the proper relation between the bars of reflector **40** and the E-vector of the radiant energy it is necessary that radiating element **37** rotate at the same speed as reflector **40**.

While preferred embodiments of this invention have been particularly described and illustrated it will be understood that various other modifications and improvements may be made without departing from the spirit of the invention. Therefore, it is not desired that the invention be limited to the precise details set forth.

What is claimed is:

An antenna for a high frequency communication system comprising a paraboloidal reflector arranged with its axis perpendicular to a ground plane, radiating means located at the focal point of said reflector, said radiating means and said paraboloidal reflector being adapted to direct electromagnetic waves of energy vertically upward, a base, a frame rotatably supported on

said base and surrounding said reflector, means for rotating said frame and said radiating means in the same direction and at the same speed, a plurality of supporting members secured to and extending upwardly from said frame, and an auxiliary reflector supported by said members near their upper extremities, said reflecting surface comprising a plurality of parallel substantially flat strips of conducting material arranged with their planes parallel to the E-vector of the radiant energy, and wherein the distance between the adjacent strips is not more than half the wave length of the radiant energy, said reflecting surface being disposed at an angle of 45° relative to the latus rectum plane of said paraboloidal reflector whereby said auxiliary reflector is adapted to reflect said upwardly directed radiant energy in a horizontal direction.

LESTER C. VAN ATTA.

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