Dec. 6, 1955 I. R. TAYLOR 2,726,389

ANTENNA UNIT

Filed Oct. 29, 1951

Fig. 1

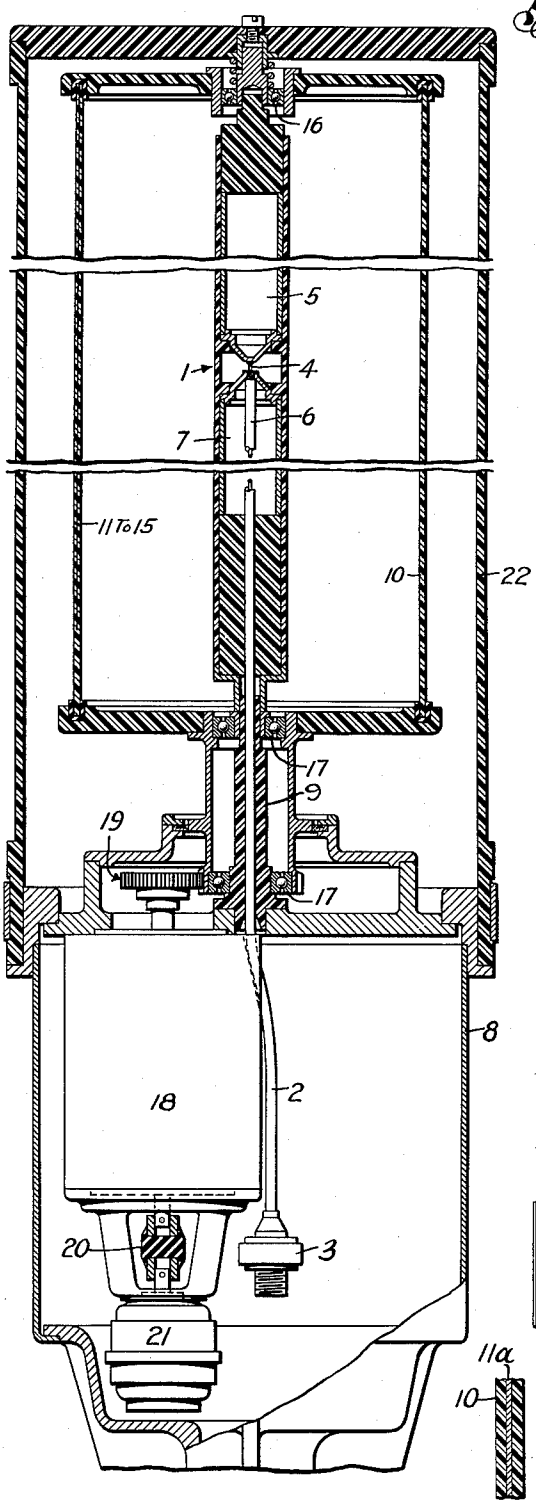


Fig. 2

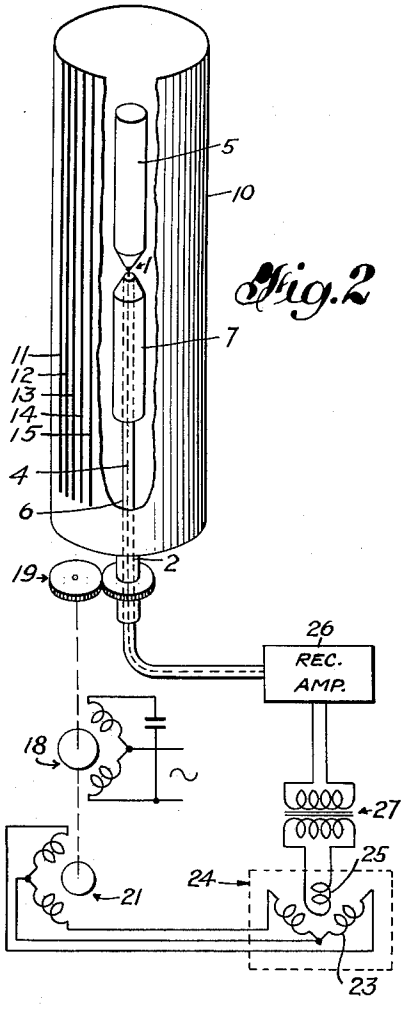


Fig. 3

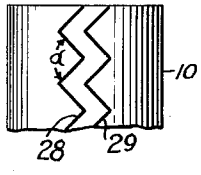


Fig. 4

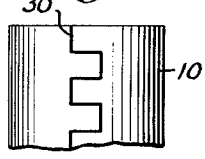


Fig. 5

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ANTENNA UNIT

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10 Claims. (Cl. 343—761)

This invention relates to antenna units and more particularly to broad band antennas for operating at ultra high frequencies.

In many antenna systems, particularly those used in direction finding systems, it is desirable that the antenna have a rotating directional pattern and be sensitive only to vertically polarized waves. It is well-known that in order to design a wide band dipole antenna, it is necessary to make the diameter of the dipole a substantial fraction of the wavelength of the frequency for which the antenna is designed. However, as the diameter of the dipole is increased, the antenna's sensitivity to horizontal polarizations will increase. In some instances it is desirable to rotate the directional pattern of the vertical antenna, and this may be done by means of a rotating reflector. Horizontally polarized waves, however, tend to induce voltages in antennas having reflectors whose width is a substantial fraction of the wavelength of the received radiation. Thus, antenna units having reflectors of this type will introduce polarization errors in the direction finding systems.

One of the objects of this invention, therefore, is to provide a directional antenna utilizing a rotating reflector which is substantially insensitive to horizontally polarized waves.

Another object of this invention is to provide a wide band antenna having a rotating directional pattern capable of receiving substantially only vertically polarized radiations.

A further object of this invention is to provide a wide band vertical antenna arrangement having a rotating reflector and being of sturdy construction.

According to a feature of my invention, a wide band coaxial dipole antenna is mounted on a mast. A parasitic reflector is rotated around the dipole thus establishing a rotating directional antenna pattern. The reflector comprises a cylinder made of an insulating material having on an arc of its circumference a plurality of conductive strips, each strip having a length substantially equal to a half wavelength and of a width necessary for adequate conduction. Due to the relatively narrow width of the strips, the reflector has a minimum response to horizontally polarized radiations and because of its length has a maximum response to vertically polarized waves.

In accordance with a further feature of this invention for use at low frequencies, the reflector strips may be composed of zigzag or Grecian fret strips of conductive material in order to reduce the overall physical length of the half wavelength reflector.

The above-mentioned and other features and objects of this invention and the manner of attaining them will become more apparent by reference to the following description taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a vertical cross-sectional view of a preferred embodiment of this invention;

Fig. 2 is a perspective view with parts broken away showing the antenna and reflector arrangements of the invention coupled in circuit for direction finding purposes;

Figs. 3 and 4 are illustrations of alternate forms of the reflector strips for use at lower frequencies; and

Fig. 5 is a cross-sectional view of a constructional detail that may be used in manufacturing the reflector feature of the invention.

Referring to Figs. 1 and 2 of the drawing, wherein a preferred embodiment of this invention is illustrated, it is shown that the antenna unit comprises a coaxial dipole antenna 1. A coaxial transmission line 2, terminating at one end in a coaxial connector 3, has its inner conductor 4 coupled to the upper element 5 of said dipole 1 and its outer conductor 6 coupled to the lower element 7 of said dipole 1. The dipole 1 is electrically insulated from and supported by a supporting structure 8 by means of a dielectric material 9. Concentric to said dipole 1 is a cylinder 10 composed of an insulating material such as fiberglass which does not affect the radiation pattern of the antenna. A plurality of conductive strips 11–15 is disposed either within the wall of the cylinder 10, Figs. 1 and 5, or on the surface thereof, Figs. 1, 3, and 4, which function as a parasitic reflector. The cylinder 10 supporting the reflector is supported by means of bearings 16 and 17 which permit the reflector to be rotated around the dipole 1, thus rotating the directive pattern of the antenna unit. The reflector cylinder 10 is mechanically rotated by means of a motor 18 and gearing mechanism 19. A mechanical link 20 between the motor 18 and alternator 21 permits the alternator 21 to be driven in synchronism with the reflector cylinder 10. Surrounding the antenna unit is a protective drum 22 composed of a material such as fiberglass which does not affect the radiation pattern of the antenna. Bearing 16 is supported by the top of the protective drum 22 which also supports the top of the dipole antenna 1.

In order to have a response over a comparatively wide frequency range, the antenna 1 is a low Q wide band coaxial dipole. The design of such a dipole antenna, in order to have a wide frequency response, requires a diameter which is relatively large when compared to the wavelength of the radiations for which it is designed, and because of this large diameter, the antenna will be sensitive to horizontal polarization. The lower half 7 of the dipole is coupled to the outer conductor 6 of the coaxial transmission line 2 and shields the transmission line, thus preventing it from affecting the radiations received by the antenna unit. The length of the dipole is designed so that it is resonant at the median frequency of the frequency band for which it is to be used. The reflecting strips 11–15 each have an electrical length equal to one-half the wavelength at the lower end of the frequency band of the low Q dipole. The width of each conducting strip is made as narrow as possible consistent with the requirement that the strips provide adequate conduction. Thus, they may consist of a plurality of wires or ribbons of conductive material, or they may be painted on the cylinder 10 with a metallic or conductive paint. The reflector, because of the narrow width of the reflecting strips, is insensitive to horizontal polarization but does reflect vertically polarized waves, thus, in effect, cancelling the tendency of the wide band dipole to be sensitive to horizontal polarizations. The spacing between strips is small enough to provide adequate reflection of the vertically polarized waves and wide enough to prevent excess capacitance between strips 11–15 which might change the electrical length of the strip or might present the equivalent of a solid reflector area and thus reflect horizontally polarized radiations. The distance between dipole 1 and the reflector strips is of the order of .07 to .12 wavelengths.

The parasitic reflector may be formed by placing the conductor strips 11–15 in a plane parallel to a plane of the vertical dipole antenna. This configuration, however, has the disadvantage that the rotating reflector would then be unbalanced and, therefore, compensating means would be required.

One form of antenna unit that has been found satisfactory for a frequency band of 225 megacycles to 400

megacycles comprises a coaxial dipole 19 inches long and conducting reflector strips 22 inches in length which are electrically resonant at 215 megacycles. The reflector strips are painted on the insulating material of the reflector cylinder with silver paint, each being an eighth of an inch wide and spaced one half inch apart upon a radius of four inches. The spacing between dipole and reflector is 3½ inches.

Referring to Fig. 2, the embodiment of this invention is shown connected in a circuit for direction finding purposes. In this arrangement the reflector is rotated by means of the motor 18 which also drives alternator 21 in synchronism therewith. The alternator 21 feeds a reference voltage to the stator windings 23 of a phase meter 24. The antenna transmission line 2 is coupled to the rotor winding 25 of the phase meter 24 through a receiver and amplifier 26 and a high impedance 27. The azimuth of the received signal may be indicated by the rotation of the rotor 25 and phase meter 24 in response to the phase relation of the received signal from the dipole antenna 1 and the reference voltage from the alternator 21.

When a received signal is fed to the rotor winding 25, the phase meter 24 will act as a motor. To counteract the tendency of the phase meter to act as a motor, it is necessary to reduce the current in the rotor winding 25. This may be done by introducing a high impedance into the transmission line 2 between the amplifier 26 and the rotor winding 25 of the phase meter. This high impedance may take the form of a high impedance transformer 27 between the amplifier 26 and the rotor winding 25 of the phase meter 24.

When used in lower frequencies, the physical length of the reflector strips would be excessive. In order to overcome this, alternate configurations of the reflector strips may be used as shown in Figs. 3 and 4. Fig. 3 shows two reflector strips 28 and 29 in zigzag form. The zigzag angle α should not be less than 45° in order to minimize the capacitance between adjacent portions of the reflector strip. Parallel zigzag strips may be added, but these additional strips should be limited to two or three due to the capacity between strips which would tend to simulate a continuous surface and thus reflect horizontal polarizations.

Fig. 4 shows a reflector strip 30 of Greek fret design. When of this design, only one reflector strip is needed for adequate reflection of the vertically polarized waves. The distance between parallel portions of the strip should be great enough to prevent excess capacitance from being introduced and changing the electrical length of the reflector strip.

Referring to Fig. 5 of the drawing, a cross-sectional view of the reflector cylinder 10 is shown with a reflector strip 11*a* embedded therein. The reflector may be formed by placing or painting the reflector strips such as strip 11*a* on a surface of insulating material such as fiberglass and then applying another sheet of insulating material thereover to form a lamination incorporating the conductive strips. Alternate methods of construction of the reflectors may be used such as painting the reflector strips 11*a* on the inner surface of a cylinder or by inlaying conductive wires or ribbons in the wall of its cylinder.

While I have described above the principles of my invention in connection with specific apparatus, it is to be clearly understood that this description is made by way of example only and not as a limitation to the scope of my invention as set forth in the objects thereof and in the accompanying claims.

I claim:

1. An antenna system comprising antenna means having a vertically polarized characteristic vertically disposed, means to support said antenna means, a cylinder of insulating material mounted concentrically about said antenna means, conducting strips carried by said cylinder, and means to rotate said cylinder.

2. An antenna system comprising antenna means having a vertically polarized characteristic, means to support said antenna means, a protective cover of insulating material surrounding said antenna means, a cylinder of non-radiating material disposed concentrically about said antenna means, means carried by said cover to support said cylinder for rotation, a plurality of strips of conducting material carried by said cylinder, and means to rotate said cylinder.

3. An antenna system according to claim 2, wherein said strips comprise a plurality of conductive wires each having an electrical length substantially equal to a half wavelength long.

4. A system according to claim 2, wherein said strips comprise a plurality of parallel painted stripes each substantially one-half wavelength long spaced from said dipole .07 to .12 wavelength and of a width to provide adequate reflection.

5. A system according to claim 2, wherein said strips comprise a plurality of ribbons composed of conductive material, each a half wavelength long and of a width necessary to provide adequate reflection.

6. A system according to claim 2, wherein said conductive strips are in the form of a plurality of spaced zigzag strips having a zigzag angle not less than 45° having a physical height substantially less than one-half wavelength long and an electrical length substantially equal to one-half wavelength.

7. A system according to claim 2, wherein said strips comprise a conductor a half wavelength long in the form of a Greek fret having a physical height substantially less than one-half wavelength long and an electrical length substantially equal to one-half wavelength.

8. An antenna system comprising a supporting base, a vertically disposed vertically polarized antenna carried by said base, a cylinder of non-radiating material disposed concentrically about said antenna, a plurality of reflecting strips carried by said cylinder and means to rotate said cylinder.

9. An antenna system comprising a supporting base, a vertically disposed vertically polarized antenna carried by said base, a cylinder of non-radiating material disposed concentrically about said antenna, a plurality of conducting strips carried by said cylinder, a protective drum of non-radiating material to enclose said antenna and said cylinder, said base having a bearing connected to the lower end of said cylinder to support the base of said cylinder for rotation, said drum having a bearing connected to the upper end of said cylinder to support said cylinder for rotation, and means to rotate said cylinder.

10. An antenna system comprising a supporting base, a vertically disposed vertically polarized antenna carried by said base, a cylinder of non-radiating material disposed concentrically about said antenna, a plurality of conducting strips carried by said cylinder, a drum of non-radiating material to enclose said antenna and said cylinder, said base having a bearing connected to the lower end of said cylinder to support the base of said cylinder for rotation, said drum having a bearing connected to the upper end of said cylinder to support said cylinder for rotation, means to rotate said cylinder about said antenna, and means to couple a source of energy to said antenna through the bearing in said base.

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