Feb. 6, 1951

H. J. RIBLET

2,540,757

ANTENNA

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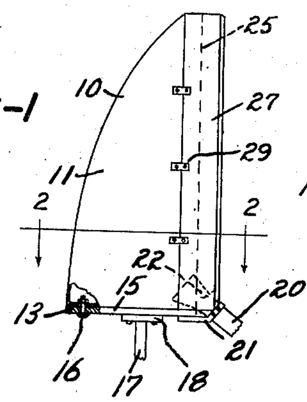
FIG-1



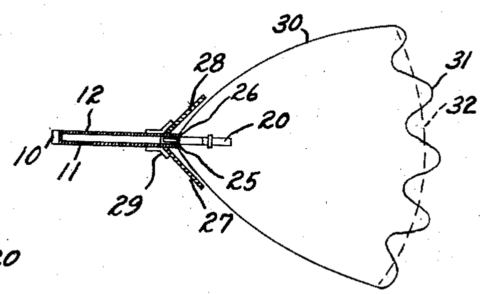


FIG-2

FIG-3

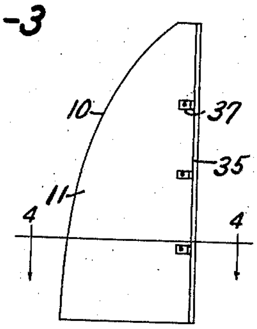


FIG-4

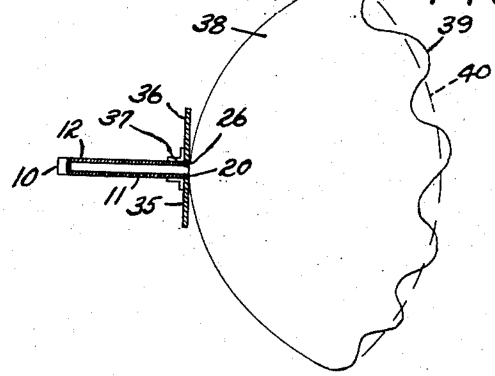


FIG-5

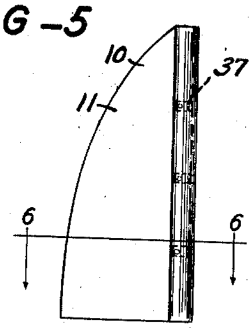
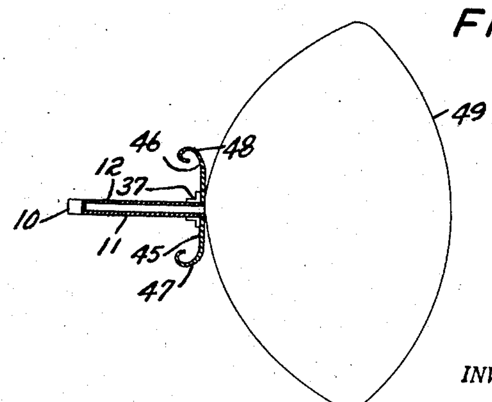


FIG-6



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2,540,757

UNITED STATES PATENT OFFICE

2,540,757

ANTENNA

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2 Claims. (Cl. 250—33.65)

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This invention relates to an antenna and more particularly to a directional antenna of the reflector type.

The principal object of the invention is to provide an antenna adapted to radiate a vertically narrow beam that is generally uniform over a substantial range in azimuth. To this end, the antenna utilizes a so-called pillbox type of reflector together with certain modifications which in combination with the reflector constitute the subject matter of the invention.

Heretofore a pillbox type of reflector has been used to obtain a narrow, highly directional radiation pattern, the pattern being narrow in azimuth as well as elevation. As is well known, a pillbox type reflector utilizes a metallic reflecting parabolic cylinder (or another reflector of suitable shape), the parabolic surface thereof usually being used relied upon to narrow the radiation pattern in the elevational coordinate. Plane parallel metallic walls enclose the ends of the parabolic cylinder, the walls cooperating to give a directional characteristic to the pattern in the azimuth coordinate. If desired, the device may be rotated through 90° whereupon the parabolic cylinder narrows the radiation in azimuth, and the walls in elevation.

A reflector of this character may be excited in various ways, one example being by a wave guide terminating in a horn disposed on the focal axis of the parabolic cylinder. Suitable dipoles or other means may be used for this purpose, if desired. As mentioned, the radiation pattern obtained by a pillbox antenna of this character is highly directional both in azimuth and elevation.

The present invention utilizes this pillbox type reflector to provide an antenna having a relatively wide and generally uniform radiation pattern in one coordinate, usually azimuth, the pattern being substantially free of objectionable side lobes. This unexpected result may be obtained by modifying the highly directional effect of the plane parallel walls of the reflector. This modification is effected by the use of two diverging plane metallic members, hereinafter called flaps, extending from the reflector walls, one on each side of the reflector mouth. As will be understood, the reflector mouth is the open side of the reflector from which radiations emanate into free space. These flaps constitute a continuation of the usual walls of the reflector, the width of the flaps in the direction of radiation having a substantial value such as three or four wave lengths of the frequency used. As mentioned, a substantial range of uniform azimuth coverage is obtained through the use of such flaps.

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It has been found that a relationship exists between the angle enclosed by the diverging metallic flaps and the range in azimuth over which the radiation is substantially uniform. In general, the greater the angle defined by the flaps, the greater is the uniform range in azimuth.

In all instances of angular relation between flaps (0° to 180°) it is possible to obtain desirable results with the flaps joined to the reflector in the plane of the reflector mouth. However, it has been found herein that improved uniformity of azimuth response (and sharper cutoff at the desired limits of the range) may be obtained by backsetting the flaps somewhat in relation to the plane of the mouth. The distance the flaps are backset depends to a large extent upon the angle enclosed by the flaps. In general, the smaller the angle between flaps, the greater the distance between the plane of the reflector mouth and the points on the reflector walls where the flaps are attached.

When the flaps are disposed at an angle of 180° with each other (the angle for maximum azimuth range), most uniform azimuth response and sharpest cutoff are obtained when the flaps are disposed in the plane of the reflector mouth. That is, the flaps are not backset, but rather they are attached to the ends of the reflector walls.

It has been stated that a pillbox type reflector provided with diverging flaps radiates a substantially uniform pattern over a predetermined azimuth range. However, minor variations in intensity do exist, although the mean radiation pattern coincides closely with the segment of a circle having its center at the antenna, the segment being defined by the angle of predetermined azimuth range. If desired, these minor variations in intensity may be substantially eliminated by curving the extremities of the flaps at an increasing rate of curvature as the flap ends are approached. The application of such curved ends to flaps of this character and a discussion of the operation of such curved ends are disclosed in the patent to Gerald L. Tawney, No. 2,469,419. As mentioned, the use of curved flaps tends to smooth out minor variations in intensity with the result that the radiation pattern is substantially circular over the azimuth range.

In the drawing, Fig. 1 is a side elevational view of a pillbox type reflector having flaps disposed at an angle of less than 180° with each other; Fig. 2 is a sectional view on the line 2—2 of Fig. 1 showing in somewhat diagrammatic fashion the radiation pattern of the antenna; Fig. 3 is a side elevational view of a pillbox type reflector having flaps disposed at an angle of 180° with each other;

Fig. 4 is a sectional view on the line 4—4 of Fig. 3 and showing, similarly to Fig. 2, a radiation pattern; Fig. 5 is a side elevational view of a reflector having 180° flaps, the flaps being terminated in a gradually increasing curve and Fig. 6 is a sectional view on the line 6—6 of Fig. 5.

Referring to Figs. 1 and 2, a pillbox type reflector may comprise a metallic semi-parabolic cylinder 10 having its ends closed by parallel metallic end walls 11 and 12. As will be understood, the use of a semi-parabolic reflector is merely exemplary and, if desired, the more usual symmetrical parabolic cylinder may be used. The width of cylinder 10 is generally small as compared to the wave length used with the reflector, a width of one-third wave length being a satisfactory value in this instance. A metallic bottom closure 13 lying generally along or parallel to the axis of the parabola is suitably associated with cylinder 10 and walls 11 and 12, as shown in Fig. 1.

A base member 15 is rigidly secured to bottom closure 13 in any suitable manner, as by bolts 16. A reflector supporting structure 17 has an enlarged top portion 18 rigidly secured to member 15. Supporting structure 17 is adapted to support the reflector in a suitable radiating position.

The reflector may be excited in any desired manner, one example being by a wave guide 20 rigidly fixed to member 15 as by a bracket 21. Wave guide 20 may be terminated in a flared horn 22, the dimensions of the horn and the angular relationship between the axis of wave guide 20 and the axis of the parabola being determined in accordance with practice well known in the art. In general, the radiating aperture of horn 22 lies on the focal axis of the parabolic cylinder whereby radiations from the aperture are reflected from the cylinder along substantially parallel paths. Wave guide 20 extends from any suitable source of high frequency energy.

The reflector mouth is defined by open ends 25 and 26 (Fig. 2) of end walls 11 and 12, respectively. Plane metallic flaps 27 and 28 are rigidly fixed to end walls 11 and 12, respectively, a plurality of angle brackets 29 being conveniently used to support the flaps in position. As shown in the drawing, flaps 27 and 28 are vertically substantially co-extensive with end walls 11 and 12, the vertical planes of an associated wall and flap, such as wall 11 and flap 27, being at a horizontal angle with each other. Flaps 27 and 28 extend symmetrically from their respective associated end walls, the horizontal angle between flaps having a value determined by presently to be described considerations. For best results the flaps should have substantial width in the direction of radiation from the reflector mouth, a value of three or four wave lengths of the frequency used being satisfactory.

As mentioned above, the use of flaps at the reflector mouth has the effect of increasing the angular range of radiation in one coordinate, in this case the horizontal or azimuth coordinate. It has been found that the range of effective azimuth coverage is generally proportional to the angle enclosed by the diverging flaps 27 and 28. Thus, for example, if the enclosed angle is relatively small, such as 40°, the range of azimuth coverage is likewise small, while if the enclosed angle is relatively large, such as 150°, the range of azimuth coverage is correspondingly large.

In order to obtain a substantially uniform coverage of a predetermined range in azimuth,

it has been found advantageous to backset the point of juncture of the flaps and the end walls with respect to the reflector mouth. While the reasons for so backsetting the flaps are not simple, an improved match between the reflector and free space is obtained through this expedient. It also has been found that a relationship exists for optimum uniformity of radiation pattern between the amount the flaps are backset from the mouth and the angle enclosed by the diverging flaps. In general, this relationship is an inverse one; the smaller the angle between flaps, the greater is the value of setback.

The somewhat diagrammatic radiation pattern of Fig. 2 shows in full line 30 the approximate energy distribution of the antenna. It will be seen that minor variations in field strength along the line 31 do exist, although the mean pattern of radiation, shown in dotted line 32, substantially coincides with a circular segment having its center at the antenna. With certain hereinafter described modifications of the flaps, the actual radiation pattern may be made to coincide closely with dotted line 32.

Referring now to Figs. 3 and 4 wherein parts thereof also shown in Figs. 1 and 2 bear similar reference numbers, a pillbox type reflector is provided with plane metallic flaps 35 and 36. Flaps 35 and 36 may be secured to end walls 11 and 12 respectively by a plurality of angle brackets 37. The reflector supporting structure and means for exciting the reflector are not shown, although it will be understood that such members may correspond to those described above.

The principal characteristic of the embodiment shown in Figs. 3 and 4 is the angular relationship between the diverging flaps 35 and 36. In this instance, the angle between flaps is 180°, this angle being chosen to provide a maximum range of substantially uniform energy distribution in azimuth. As shown in Fig. 4, optimum uniformity in azimuth is obtained when flaps 35 and 36 lie generally in the plane of the reflector mouth, i. e. the flaps are not backset as described above in connection with flaps enclosing angles of less than 180°. The radiation pattern 38 is substantially uniform, although minor variations shown at 39 do exist. Here again, the mean radiation pattern shown in dotted line 40 is circular.

Figs. 5 and 6, wherein like reference numerals for like parts are used, show a pillbox type reflector provided with flaps 45 and 46 disposed at 180° with each other. In this instance, flaps 45 and 46 have their extremities 47 and 48, respectively, curved, the rate of curvature preferably increasing as the flap ends are approached. The curves generally may have an exponential form. Such curved extremities provide an improved match for transferring energy between the antenna and free space with the result that the above-mentioned minor variations in energy distribution are substantially eliminated. The radiation pattern 49 thus is substantially circluar. It will be understood that the same desirable result may be obtained by providing curved extremities on flaps disposed at other angles with each other. Use of such curved flaps is disclosed and claimed in the above-mentioned co-pending application.

Having thus described the invention, what I claim as new and desire to secure by Letters Patent is:

1. A reflector type antenna including a source of radio frequency wave energy, a reflecting cylinder adapted to narrow reflected radiations in one

coordinate, plane parallel walls enclosing the ends of said cylinder and spaced a fraction of the wavelength of said energy to narrow reflected radiations in the second coordinate of a two coordinate system, the ends of said walls defining an open mouth of said cylinder said source being disposed in operative relationship with said reflecting cylinder, and metallic flaps associated with said walls and extending symmetrically and at an acute angle with each other from said walls, said flaps having a width away from said walls corresponding generally to several wave lengths of the radio frequency used, whereby radiations from said antenna are generally uniform over a substantial range in said second coordinate, the actual range provided being a function of the angle enclosed by said flaps, said flaps being backset on said walls with respect to said reflector mouth, the distance of backset for a given size of reflecting cylinder being generally inversely proportional to the angle enclosed by said flaps.

2. A reflector type antenna including a source of radio frequency wave energy, a reflecting cylinder having an open mouth adapted to narrow reflected radiation in one coordinate, plane parallel walls enclosing the ends of said cylinder and spaced a fraction of the wavelength of said energy to narrow reflected radiation in the second coordinate of a two coordinate system, said source being disposed in operative relationship with said reflecting cylinder, and metallic flaps extending from said walls symmetrically and at acute angle

to said walls, said flaps having a width away from said walls corresponding substantially to several wavelengths of said energy, said flaps being backset on said walls with respect to said reflector mouth, the distance of backsetting for a given size of reflecting cylinder being generally inversely proportional to the angle enclosed by said flaps, whereby radiation from said antenna is generally uniform over a substantial range of said second coordinate.

HENRY J. RIBLET.

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