

Sept. 24, 1957

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2,807,800

HIGH FREQUENCY DIRECTIONAL AERIALS

Filed Sept. 13, 1955

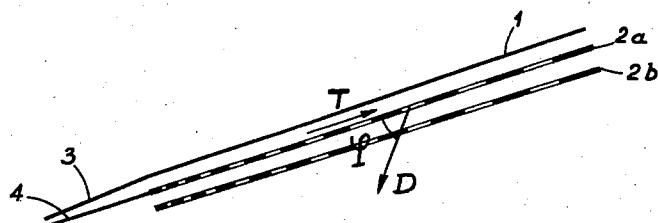


FIG. 1

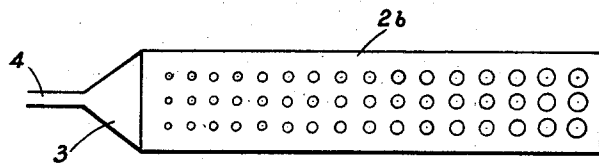


FIG. 2

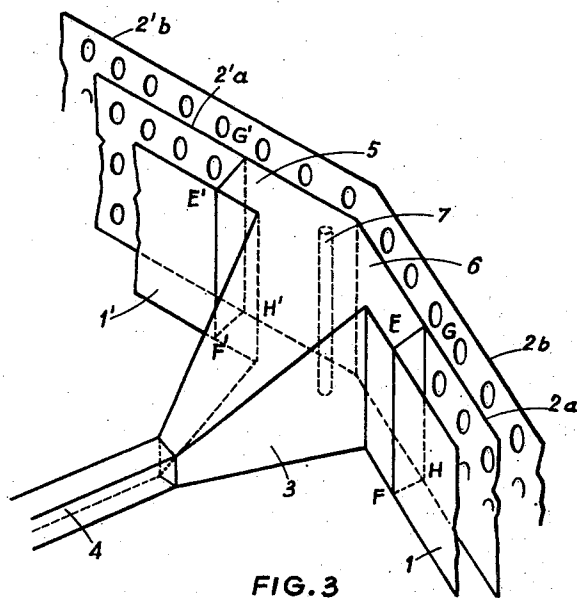


FIG. 3

1

2,807,800

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Application September 13, 1955, Serial No. 534,115

Claims priority, application France September 15, 1954

5 Claims. (Cl. 343—771)

The object of the present invention is a high frequency aerial comprising at least one reflecting solid plane metal plate and at least one perforated metal plate substantially parallel to said reflecting plate, and means for generating or receiving a wave propagating between said perforated plates and said reflecting plates and radiated through the holes of said perforated plate.

It has been found that the radiation pattern of such an aerial is a narrow beam, the axis of which forms a certain angle with the plates and whose projection on the plates is parallel to the direction of propagation of the wave between the plates.

This aerial has a wider passband and is easier to adjust than certain devices of prior art, such as that described by L. J. Chu in United States Patent 2,479,209.

The invention will be more clearly understood from the ensuing description with reference to the appended drawings which illustrate some non limitative embodiments of the invention.

In the drawings,

Figures 1 and 2 show a side and front elevation, respectively, of an aerial according to the invention, comprising two perforated plane plates and a plane reflector.

Figure 3 is a perspective view of a V-shaped aerial according to a modification.

The aerial shown in Figures 1 and 2 comprises a solid rectangular reflecting metal plate 1 and two rectangular metal plates 2a and 2b perforated with circular holes, the respective centers of which are aligned in three rows lengthwise and sixteen rows broadwise. The respective diameters of the broadwise located holes are equal to each other and those of the lengthwise located holes increase regularly from one end of the plate to the other. All these plates are coextensive, and in the particular embodiment shown, vertically disposed, in order to obtain a radiation pattern having an horizontal axis of symmetry. A wave guide 4 is extended by a horn 3 whose external edges rest respectively against the edges of the shorter sides of plates 1 and 2a and that end of the structure where the holes are smaller. The plates are bolted or braced together to form a rigid structure which is positioned to obtain the desired direction of radiation in the horizontal plane.

Experience shows that if a wave is propagated through the guide 4 in a direction parallel to the plates and between plates 1 and 2, as shown by arrow T, this wave is radiated through the holes in a direction shown by arrow D forming an angle ψ with the plane of the plates. The radiation pattern of the aerial is then a narrow lobe whose axis, passing through the centers of the plates, is parallel to D.

Angle ψ is given approximately by the equation:

$$\cos \psi = \frac{\lambda}{p} - 1.1 \quad (1)$$

wherein λ is the wavelength in the free space and p is the distance between adjacent holes, either in a transverse or

2

in a longitudinal row. This equation is all the more correct as the number of perforated plates is increased whilst remaining sufficiently accurate in the particular embodiment shown in the drawing, in which there are two plates only.

This equation has been established by taking into account the fact that the radiation direction is such that the wave radiated through the holes and the wave propagating between the plates, respectively with a velocity corresponding to the wavelength in the air and to the wavelength in the guide constituted by plates 1 and 2a, are in phase in front of each hole, and supposing that $\lambda = 1.1\lambda_1$. From above Formula 1 it follows that the distance p must be comprised between

$$\frac{1}{2.1} \text{ and } 1.1$$

Applicant has found that the directivity increases with the two main dimensions of the plates; in the example described, the directivity along the horizontal plane is therefore much greater than in the vertical plane, the width of the plates being much shorter than their length.

It is finally found that by adequately determining, through calculation and experimentation, the variation law of the diameter of the holes and of the spacing of the plates, that the greatest portion of the energy is radiated before the energy has reached the plate edge opposite to that where the horn is connected, thus increasing the efficiency of the aerial. This condition will be substantially fulfilled if the characteristic impedance of the guide formed by the plates is constant from the excited end to the opposite end.

It will be noted that, contrary to the aerial described in the above mentioned patent to Chu, the aerial according to the present invention, does not comprise any reflecting element short-circuiting the end of the plates and thus forming a closed guide. The presence of such an element causes standing waves to appear, which reduces the bandwidth of the aerial.

The aerial shown in Figure 3 comprises a wave guide 4 extended by a horn 3', itself extended by two oblong metal elements 5 and 6 connected at an obtuse angle. Horn 3 and the two elements 5 and 6 constitute a hollow body which may be manufactured beforehand. Metal plates pairs 1, 1', 2a, 2'a, 2b, 2'b, are respectively connected by their respective edges to the edges EF, GH, E'F', G'H' of this body. The assembly comprising said guide, hollow body and plates has a symmetry plane in which is disposed a matching rod 7, within said hollow body. Plates 1 and 1' are solid and constitute reflecting surfaces, whereas plates 2a, 2'a and 2b, 2'b are perforated with holes of a constant diameter equal to 1.4 cm.

For a wavelength of 3.42 cm., plates 125 cm. long (length of a branch of the V) and 12 cm. wide have been used by the applicant. The angle at the apex of the V is 160°; the distance between two consecutive holes is 2.9 cm.; the spacing between plate 1 and plate 2a and between plates 1' and 2'a is 2.3 cm.; the spacing between plates 2a and 2b (or 2'a and 2'b) is 1.3 cm.

It has thus been possible to obtain radiation lobe having an opening of 1°. The aerial of Figure 3 operates in the same manner as two aerials of the type shown in Figures 1 and 2, joined in the plane of symmetry of the unit, and its radiation pattern has said plane for its plane of symmetry, i. e. the common bisecting plane of the dihedron formed by the plates.

It is of course to be understood that the scope of the invention is not limited to the embodiments shown which are given by way of examples only.

3

I claim:

1. Aerial for ultra-high frequency energy comprising in combination at least one reflecting plane solid metal plate, and on the same side of said plate a first and a second metal plate perforated with holes and substantially parallel to said solid plate, identical to and facing each other; said solid and said first perforated plate limiting a guiding space for an ultra-high frequency wave, said guiding space having a first and a second extremity and said holes facing each other respectively and being arranged in rows parallel to the direction of propagation of said ultra high frequency wave in said guiding space and in rows perpendicular thereto, and a horn disposed at the first extremity of said guiding space.

2. Aerial according to claim 1 in which said holes are circularly shaped.

3. Aerial according to claim 2 in which the holes of the same row parallel to the direction of propagation of the waves have their diameters increasing from the first extremity of the guiding space to the second extremity thereof, and the holes of the same row perpendicular to said direction of propagation have the same diameters.

4. Aerial according to claim 3 in which the distance between the centers of two consecutive holes is comprised between 0.4λ and λ , λ being the wave length of said propagating wave.

4

5. Aerial for radiating ultra-high frequency energy, comprising in combination a first and a second solid plane metal plate, identical to each other, and forming a dihedral substantially greater than 90° ; at least a first and a second identical plane metal plate perforated with holes and respectively parallel to said first and second reflecting metal plate; said first and second solid plate, said first and second perforated plate limiting, respectively, a first and a second guiding space symmetrical to each other, for a first and a second ultra high frequency energy wave, respectively; said holes being arranged, in said first and second perforated plate, in rows parallel respectively to the direction of propagation of said first and said second wave and in rows perpendicular thereto; a horn arranged in the symmetry plane of said first and said second guide, for exciting therein said first and said second wave.

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