July 25, 1944. E. GERHARD 2,354,254

DIRECTIONAL ANTENNA WITH SUPPRESSED LOBES OR EARS

Filed April 17, 1941 2 Sheets-Sheet 1

Fig. 1

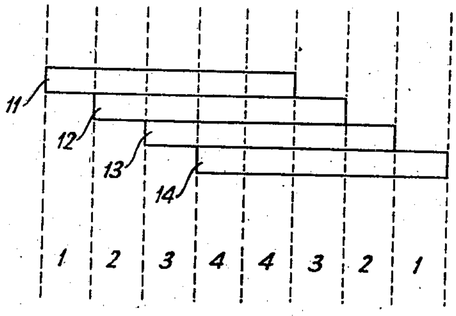


Fig. 2

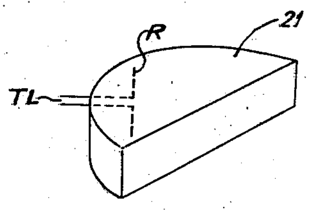


Fig. 3

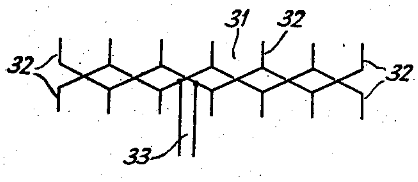
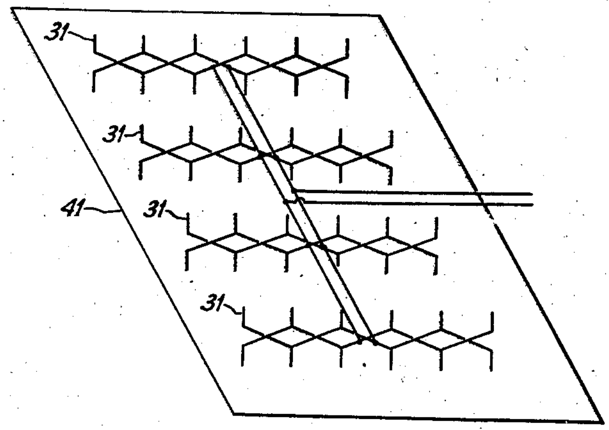


Fig. 4



INVENTOR
ERNST GERHARD
BY H. S. Grover
ATTORNEY

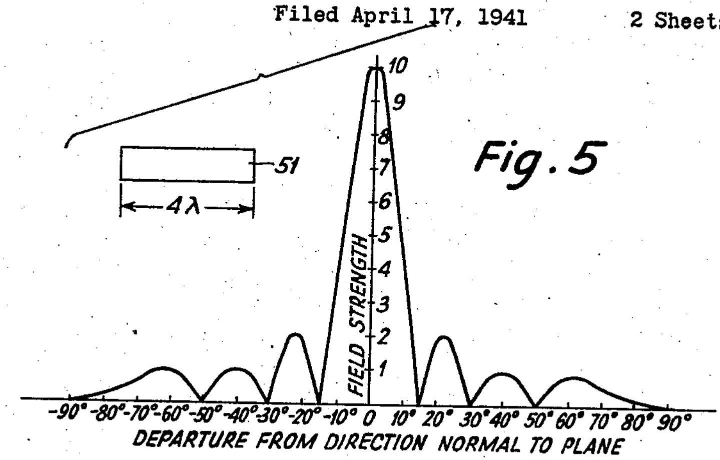


Fig. 5

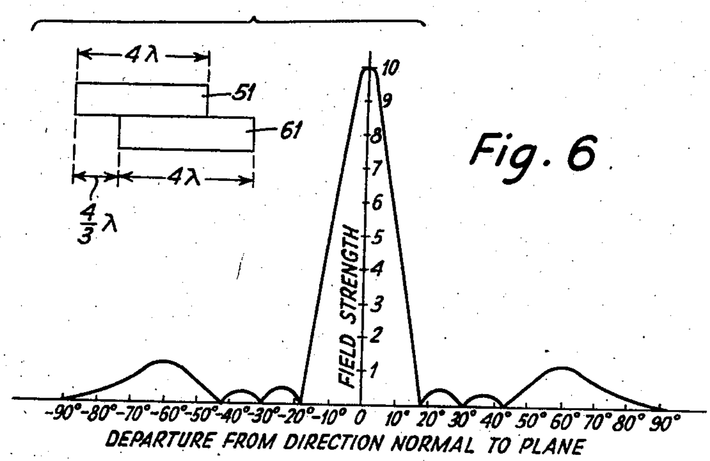


Fig. 6

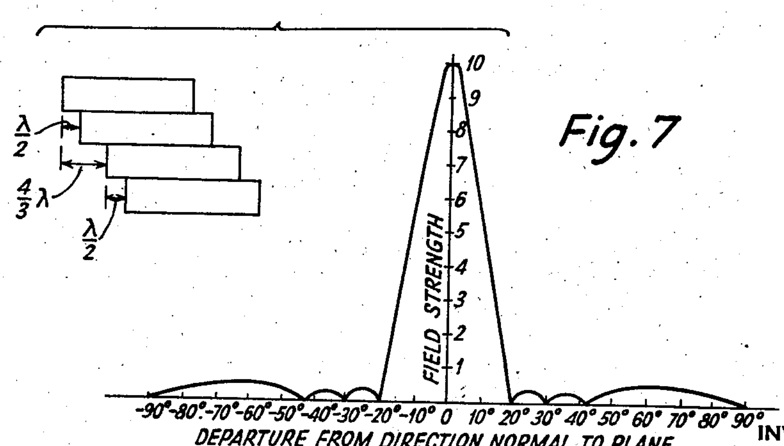


Fig. 7

INVENTOR
ERNST GERHARD
BY H. S. Grover
ATTORNEY

Patented July 25, 1944 **2,354,254**

UNITED STATES PATENT OFFICE

2,354,254

DIRECTIONAL ANTENNA WITH SUPPRESSED LOBES OR EARS

Ernst Gerhard, Berlin, Germany; vested in the Alien Property Custodian

Application April 17, 1941, Serial No. 388,936
In Germany October 7, 1939

9 Claims. (Cl. 250—11)

It is known in the prior art to suppress undesirable secondary or lateral radiations known as lobes or ears (that is, secondary maxima) which arise in connection with the operation of a directional antenna, for example, a sheet antenna, a parabola reflector, etc., by making the current distribution over the entire antenna area vary in such a way that, from a maximum at the center, it declines in conformity with a definite law in the direction towards the edges of the surface.

According to the invention, the secondary maxima or lobes, for instance, of the horizontal diagram are suppressed by arranging several aerials below one another and staggered with respect to one another in the horizontal sense. Thus any desired distribution of current of the antenna surface or area is obtainable. A staggered relationship in the horizontal direction is illustrated by the schematic embodiment, Figure 1.

The antenna shown in Figure 1 may utilize cylindrical parabola reflectors of the kind shown in Figure 2, or sheet radiators comprising a plurality of dipoles, for instance, of the kind shown in Figure 3. A number of the radiators, mounted in one plane staggered with relation to one another, may be assembled to form rhombic antenna such as shown in Figure 4. Figures 5 to 7 illustrate theoretically determined horizontal diagrams corresponding to the sheet antennae shown alongside the patterns. Figure 2 shows a perspective view of a cylindric parabola reflector **21** which may be used as each of the radiators **11**—**14** shown in Figure 1. The energizing antenna within the reflector is not shown but may be of any conventional type.

Figure 3 shows a broadside array **31** composed of a plurality of individual dipoles **32** so energized by transmission line **33** as to simulate a uniform current sheet. The individual radiating units **31** shown in Figure 3 may be combined as shown in Figure 4 in the practice of the present invention. The combination simulates a rhombic radiating sheet **41**. Due to the longitudinal stagger of the units **31** the desired radiation pattern is obtained.

Figure 5 shows the horizontal diagram of a plain sheet antenna **51** with uniform current distribution of 4λ width, λ being the operating wavelength.

Figure 6 shows the diagram corresponding to an antenna comprising two surfaces **51** and **61**, each of 4λ width, and staggered with reference to each other a distance equal to 4/3λ according to the invention. It will be noticed that the first and the second maxima are largely suppressed. Figure 7, finally, shows the diagram of an antenna comprising four sheets, each of 4λ width, staggered with respect to one another. The arrangement results from staggering two schemes as shown in Figure 6 an amount equal to λ/2 with respect to each other. In this case the third maximum has been suppressed appreciably as well as the first and second maxima.

In the exemplified embodiment of Figure 1 four sheet antennae **11**, **12**, **13**, **14**, all of which are to have a uniform current covering or distribution, are placed underneath one another. The flux of energy through the vertical sheet elements (indicated by the dash-lines) is proportional to the antenna surface contained in these surface elements. The energy flux is numerically indicated, in relative terms, for each surface element. By means of a variation of the horizontal shift and of the horizontal size of the various antenna surfaces indicated in Figure 1, any desired energy distribution in horizontal sense is attainable, with the result that only the first maximum, or only maxima of a higher ordinal number or all of them may be suppressed. The energy distribution required for each case is ascertainable by calculation by the application of known methods.

It will be understood that what has been shown in the exemplified embodiment for the horizontal direction applies naturally to any other direction. Thus a similar arrangement may be used to reduce undesired maxima in the vertical directivity pattern.

I claim:

1. A directional antenna including a plurality of radiating units, each radiating energy in a pattern having a main lobe and a plurality of supplemental lobes, said units being arranged in a vertical plane normal to the desired line of transmission, one of said units so being shifted laterally in said plane with respect to another that first and second supplemental lobes are suppressed and radiating units adjacent said one and said other unit being shifted laterally in said plane such distance that third supplemental lobes are suppressed.

2. A directional antenna array including a plurality of radiating units, each unit including a cylindric parabolic reflector having energizing means therewithin, the radiating pattern of each of said units including a main lobe and a plurality of supplementary lobes, the mouth openings of said reflectors having a lateral dimension of the order of several wavelengths, said radiating units being so arranged that the mouth openings of

said reflectors lie one above the other in a vertical plane, said units being displaced laterally in said plane each with respect to an adjacent unit a distance such that said supplementary lobes are suppressed.

3. A directional antenna array including at least a pair of radiating units, each unit including a cylindric parabolic reflector having energizing means therewithin, the mouth openings of said reflectors having a lateral dimension of the order of several wavelengths, said units being so arranged that the mouth openings of said reflectors lie one above the other in a vertical plane, one of said units being displaced laterally in said plane a distance equal to four-thirds of the operating wavelength with respect to the other.

4. A directive antenna system including a pair of antenna arrays, as set forth in claim 3, said arrays being arranged vertically one above the other and one being shifted laterally a distance equal to one-half of the operating wavelength with resect to the other.

5. A directional antenna array including a pair of radiators each characterized in that at a predetermined position with respect to said radiator there exists a plane having a uniform field distribution over an area extending transversely of the electric component of said field for a distance equivalent to at least a whole number of wavelengths, said radiators being stacked vertically one above the other, one of said radiators being displaced laterally a distance equal to four-thirds of the operating wavelength with respect to the other.

6. A directional antenna system including a pair of arrays, as set forth in claim 5, said arrays being arranged vertically one above the other and one of said arrays being shifted laterally a distance equal to one-half of the operating wavelength with respect to the other.

7. A directional antenna including a plurality of radiating units, each so constructed that at a predetermined position with respect to said radiator there exists a plane having a uniform field distribution over an area extending transversely of the electric component of said field for a distance equivalent to at least a whole number of wave lengths, said radiators being stacked vertically one above the other and said radiators being displaced laterally in a vertical plane with respect to one another a distance such that supplementary lobes of radiation are suppressed.

8. A directional antenna including a plurality of radiating units, each so constructed that at a predetermined position with respect to said radiator there exists a plane having a uniform field distribution over an area extending transversely of the electric component of said field for a distance equivalent to at least a whole number of wave lenths, said radiators being stacked vertically one above the other and said radiators being displaced laterally in a vertical plane with respect to one another a distance such that supplementary lobes of radiation are suppressed, each of said radiating units comprising a plurality of vertical dipoles arranged as a broadside array.

9. A directional antenna array, including a pair of radiating units each so constructed that at a predetermined position with respect to said radiating unit there exists a plane having uniform field distribution over an area extending transversely of the electric component of said field for a distance equivalent to at least a whole number of wave lengths, said radiating units being stacked vertically one above the other and one of said radiating units being displaced laterally with respect to the other.

ERNST GERHARD.