

343-755

U.S. PAT. OFF.

Nov. 17, 1970

G. E. EVANS

3,541,559

ANTENNA FOR PRODUCING CIRCULAR POLARIZATION OVER WIDE ANGLES

Filed April 10, 1968

2 Sheets-Sheet 1

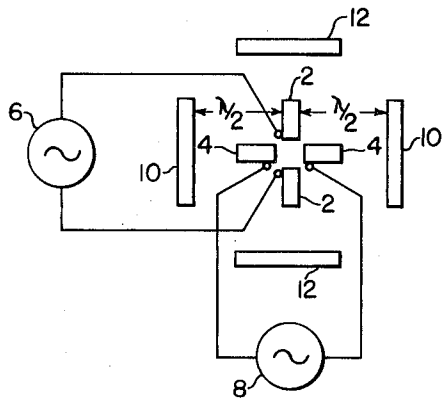


FIG. 1.

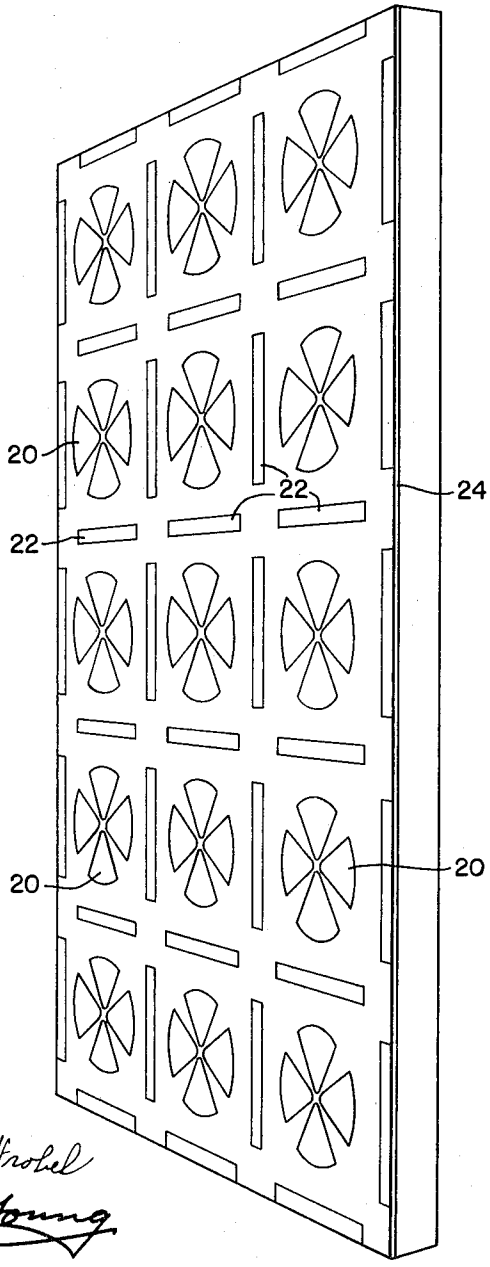


FIG. 3.

WITNESSES

Theodore F. Wrobel
James F. Young

INVENTOR

Gary E. Evans

BY *Ernest P. Klippel*
ATTORNEY

Nov. 17, 1970

G. E. EVANS

3,541,559

ANTENNA FOR PRODUCING CIRCULAR POLARIZATION OVER WIDE ANGLES

Filed April 10, 1968

2 Sheets-Sheet 2

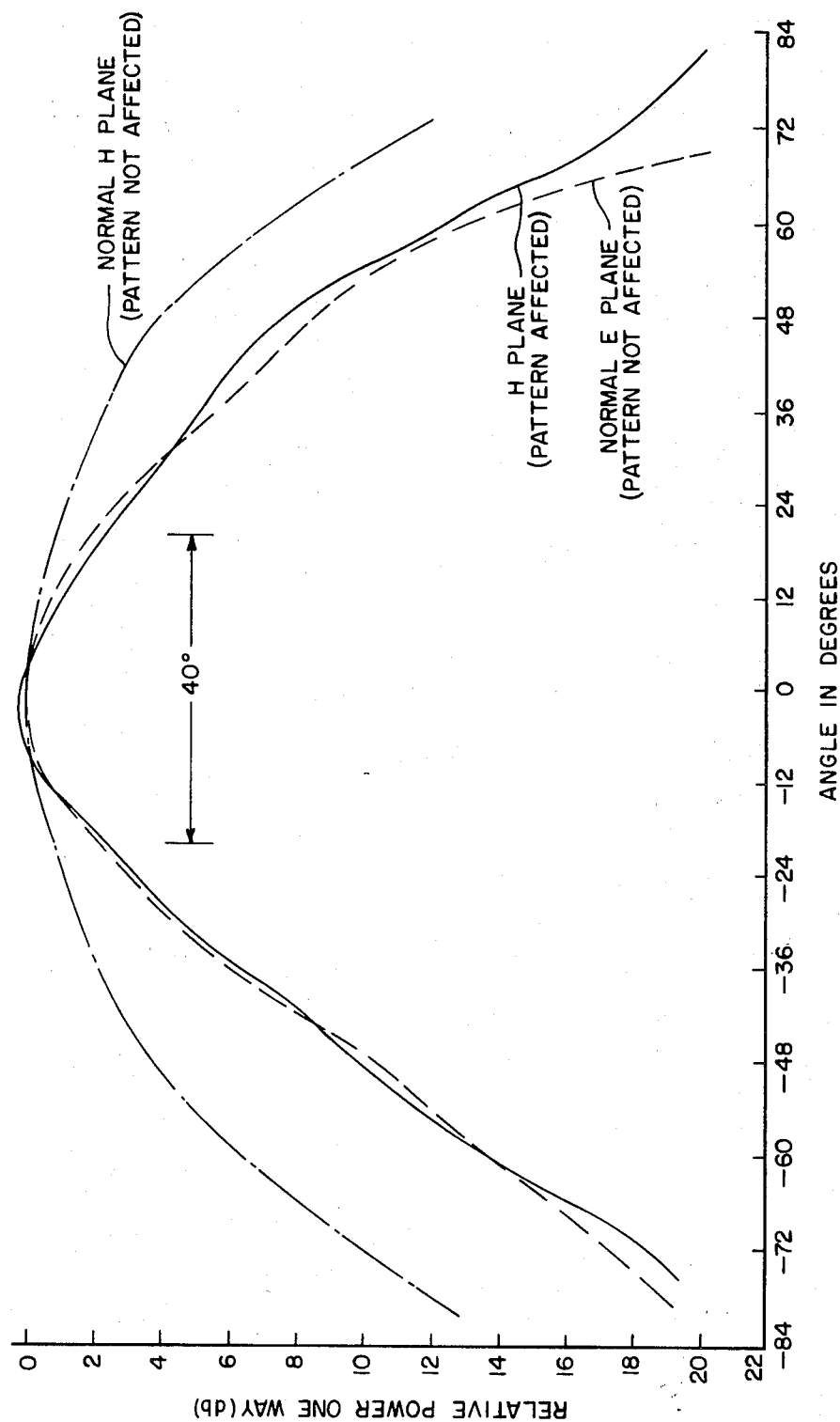


FIG. 2.

1

3,541,559

ANTENNA FOR PRODUCING CIRCULAR POLARIZATION OVER WIDE ANGLES

Gary E. Evans, Hanover, Md., assignor to Westinghouse Electric Corporation, Pittsburgh, Pa., a corporation of Delaware

Filed Apr. 10, 1968, Ser. No. 720,095

Int. Cl. H01q 9/28, 19/00, 21/26

U.S. Cl. 343-756

8 Claims

ABSTRACT OF THE DISCLOSURE

An antenna providing circular polarization over wide angles with a very low ellipticity ratio of the polarization over wide angles of the radiation pattern by disposing crossed dipoles in a square grid of parasitic reflectors. Low ellipticity is obtained by separating the reflectors by substantially an odd number of wavelengths. The parasitic reflectors are disposed about the crossed dipole radiator so as to be reflective to the electric field component disposed along their length and transparent to the electric field component normal to their length. All the metallic parts are in one plane so they may be disposed on a dielectric sheet by means of printed circuit techniques.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates generally to antennas and more particularly relates to an antenna for producing circular polarization over wide angles.

Description of the prior art

Most systems which use circular polarization require low ellipticity over the angular operating range. Many radar sets depend on low ellipticity for rejection of rain return.

The angular range may be large, as in the case of an element in a steerable array or an element illuminating a parabolic dish. Elements which radiate over wide angles do not usually maintain low ellipticity over the beam. At any instant, simple, symmetrical elements less than a wavelength square tend to have beams which are narrower in the E plane than in the H plane. For example, crossed dipoles have a figure eight pattern in the E plane and are omnidirectional in the H plane at any instant. Prefect circularity on-axis implies that the E and H plane patterns coincide on-axis and therefore generate ellipticity as the two patterns diverge off-axis. For halfwave cross dipoles, the calculated ellipticity is 3 db at 45° from beam center.

An object of the present invention is to provide an antenna producing circular polarization over wide angles.

Another object of the present invention is to obtain equal beam shapes from a crossed dipole antenna.

Another object of the present invention is to provide an antenna for producing circular polarization over wide angles wherein all metallic parts are capable of being economically packaged utilizing printed circuit techniques.

Another object of the present invention is to provide an antenna wherein the effective H plane aperture is increased to be equal to the physical aperture.

Another object of the present invention is to provide an antenna for producing circular polarization over wide angles which antenna can be printed on a single sheet.

SUMMARY OF THE INVENTION

Briefly, the present invention accomplishes the above cited objects by providing a pair of dipoles which are crossed at a 90° mechanical angle. One dipole is driven 90 electrical degrees out of phase with the drive of its associated crossed dipole. Parasitic reflectors are disposed

2

in a square configuration with the reflectors making up opposite sides of the square being disposed parallel to an associated dipole of an antenna within the square. A phased array of antennas is provided by a grid of such parasitic reflectors with crossed dipole elements disposed within each square of the grid. The antennas and the reflectors can be printed on a dielectric sheet using printed circuit techniques.

BRIEF DESCRIPTION OF THE DRAWING

Further objects and advantages will be readily apparent from the following detail description taken in conjunction with the drawing in which:

FIG. 1 is a schematic diagram illustrating the manner in which the present invention obtains the desired result;

FIG. 2 is a graphical representation of results obtained when practicing the invention; and

FIG. 3 is an illustrative embodiment of the invention.

The principles of my invention are diagrammatically illustrated in FIG. 1, which shows a first dipole 2 disposed at right angles to a second dipole 4. The first dipole 2 is driven by a source 6 whose output is 90° out of phase with the source 8 which drives the second dipole 4. The crossed dipoles 2, 4 are disposed in a square grid of parasitic reflectors. One pair of oppositely disposed parasitic reflectors 10 are positioned parallel to the first dipole 2 while a second pair of reflectors 12 are oppositely disposed and parallel to each other as well as the other dipole 4.

The effect of these parasitic elements is most readily understood by initially assuming an instant when the electrical field is vertical; that is, the radiation is entirely from the first dipole 2. At the instant that the polarization is vertical, the horizontal reflectors 12 are transparent so that the vertical beamwidth is that of a dipole in the E plane. Radiation towards the vertical reflectors 10 travels a distance of about one half of a wavelength of the electromagnetic energy beam radiated and then reverses phase on reflection so that it adds in-phase with the direct signal normal to the surface. The net effect is that the dipole element 2 appears to be wide and has a narrow H plane beamwidth.

When the polarization is horizontal; that is when the other dipole 4 only is radiating, the vertically disposed parasitic elements will be transparent so that the horizontal beamwidth is also that of a dipole in the E plane.

At other instants the parasitic reflectors 10 and 12 will be reflective to the E component disposed along the length of the parasitic reflectors and transparent to the instantaneous total electric field normal to the length of the parasitic reflectors.

Referring to FIG. 2, measured dipole patterns are shown for the crossed dipoles of FIG. 1. The pattern of the H plane may be closely matched to the E plane pattern by adjusting the parasitic reflector dimensions such as width and/or length. The reflector is a resonant element, much like the dipole itself. The resonant frequency and Q are determined by the length and width, respectively. Choosing these in combination determines the fraction of power intercepted and the phase shift added in re-radiation at the operating frequency. This permits equalizing patterns over a range of reflector spacings about one half of a wavelength. This is necessary if the aperture is determined by other factors.

An array of such antennas for phased array operation is illustrated in FIG. 3. Crossed dipoles 20 are disposed in each square of a grid of parasitic reflectors 22, opposite legs of which are disposed in parallel with associated dipoles of each antenna. Means for driving each crossed dipole 90 electrical degrees out of phase with each other is connected to the dipoles by leads extending through a dielectric sheet 24. Since all the metallic parts are in one

3

plane, the elements or arrays of elements can be readily fashioned of printed circuits on the dielectric sheet 24.

The use of metallic coated printed circuit materials with patterns etched or deposited thereon or therein allows for economical packaging. This is not possible with methods of the prior art for equalizing which use modified feed horns. Also, the arrangement of the present invention increases the effective H plane aperture to be equal to the physical aperture. This increase results from the fact that energy is now radiated from three sources spread over the entire aperture; that is, the driven dipole plus the two parasitic reflectors, rather than the driven dipole alone. The present invention is a considerable improvement over the standard method of using fins in feed horns which equalize patterns by decreasing the E plane aperture below the physical aperture. Horns using such a conventional design cannot be stacked close together in front of a dish and offer poor grating lobe suppression as array elements.

While the present invention has been described with a degree of particularity for the purposes of illustration, it is to be understood that all modifications, substitutions and alternations within the spirit and scope of the present invention are herein meant to be included.

I claim as my invention:

1. In combination; a circularly polarized radiator of electromagnetic energy; and a substantially square grid of parasitic reflectors disposed about said radiator to be reflective to the electric field component along the length of said parasitic reflectors and transparent to the electric field component normal to the length of said parasitic reflectors.

2. The apparatus of claim 1 wherein said substantially square grid of parasitic reflectors is substantially one wavelength of the electromagnetic energy in size.

3. The apparatus of claim 1 wherein said radiator includes crossed dipoles.

4. The apparatus of claim 2 wherein said parasitic reflectors are disposed in a substantially square grid the

4

size of any odd number of wavelengths of the electromagnetic energy.

5. The apparatus of claim 3 wherein said crossed dipoles are oriented at right angles to each other.

6. The apparatus of claim 5 including means for driving one set of dipoles 90 electrical degrees out of phase with the drive of its associated dipole which crosses said one dipole.

7. The apparatus of claim 1 wherein at least two of said parasitic reflectors have different dimensions, for modifying the plane of the magnetic field to have the same physical characteristics as the plane of the electric field whereby a narrow beamwidth is obtained in both planes over a wide bandwidth.

8. In combination; a dielectric sheet; a grid of parasitic conductors printed on said dielectric sheet; a crossed dipole antenna positioned within each grid and also disposed on said dielectric sheet; means for individually energizing one dipole of each crossed dipole element; and means for energizing the other dipole of each crossed element with energy 90 electrical degrees in displacement from the energy to said first dipole.

References Cited

UNITED STATES PATENTS

3,273,158	9/1966	Fouts et al.	-----	343—797 X
3,307,188	2/1967	Marchetti et al.		

FOREIGN PATENTS

660,553	4/1963	Canada.
---------	--------	---------

HERMAN KARL SAALBACH, Primary Examiner

T. J. VEZEAU, Assistant Examiner

U.S. Cl. X.R.

343—795, 798