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(54) Improvements in or relating to radar antenna arrays.

(57) A phased array radar antenna which comprises a structure which serves to support a co-ordinate array of uniformly spaced radiating elements wherein the height of the array along one axis thereof is tapered away from the centre of the array, thereby to afford a reduction of sidelobes in a plane orthogonal to the said one axis whilst retaining an efficient transmit/receiver function.

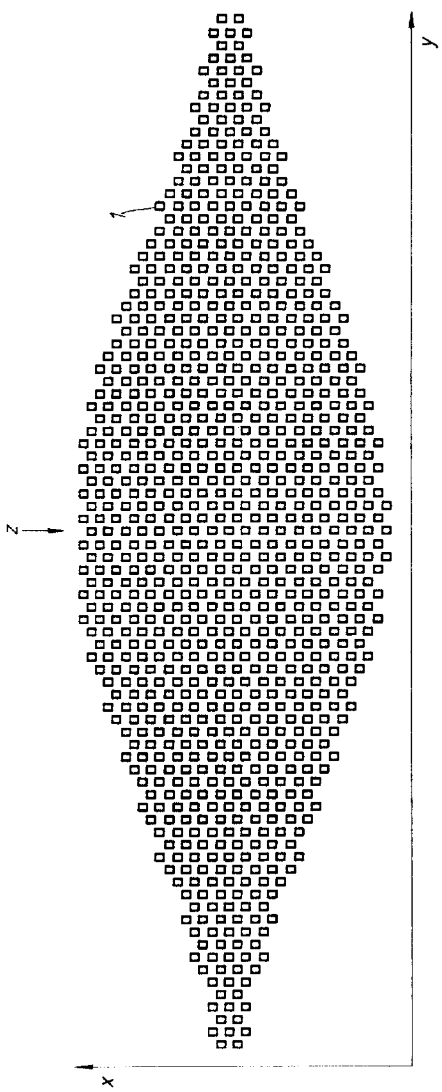

Fig.1.

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This invention relates to phased radar arrays and more especially it relates to phased planar array antennas.

Planar arrays normally extend in two dimensions perhaps to define a rectangular array, signals being radiated from elements of the array to form a beam which may be steered in accordance with the relative phase of the signals.

One of the problems associated with planar array antennas is that sidelobes of transmitted and received radar beams can be unacceptably high. One known way of reducing the amplitude of sidelobes is to amplitude weight signals applied to the elements of the array. Such weighting systems are well known and weighting may be applied in accordance with Hanning, Raised Cosine, or Taylor tapering functions for example. This known weighting technique comprises producing an amplitude taper across the face of the array, which may be achieved by control of the amplitude of signals fed to individual elements in an active array or by using a complex network of power combiners/dividers in association with strip lines which feed power to the elements of the array.

Amplitude weighting as aforesaid, has the disadvantage that it is inefficient since much of the power generated is lost in the weighting circuits. Moreover, the complexity of the array is significantly increased by the need for the provision of weighting circuitry in addition to the circuitry required for beam steering purposes. In a known alternative system, sidelobes are reduced by arranging the elements of the array in a non-uniform distribution (spatial thinning).

A disadvantage of this kind of array however is that a spatial thinning of the elements produces grating lobes at unacceptably high levels.

According to the present invention, a phased array radar antenna comprises a structure which serves to support a co-ordinate array of uniformly spaced radiating elements, wherein the height of the array along one axis thereof is tapered away from the centre of the array, thereby to afford a reduction of sidelobes in a plane orthogonal to the said one axis.

The tapering may be arranged to be uniform about the array centre along one axis thereby to produce an array which is symmetrical about the array centre along the said one axis.

In an array according to the present invention the element spacing may be arranged at approximately a half wavelength. This enables the formation of grating lobes to be avoided, and, since the elements of the array are each fed with power at full amplitude, without weighting, the array efficiency is not compromised.

The taper function used to determine the height of the array from point to point along its length and thus the effective outline of the array, may be calculated in accordance with a known function such as a Hanning function, a Raised Cosine function or a Taylor function, which as hereinbefore described may be used to calculate weighting functions in known amplitude weighted systems.

In order to achieve low sidelobes in the horizontal plane for example, the vertical height, i.e the number of elements in each vertical column of elements is chosen to provide a required taper function across the array in accordance with the philosophy used i.e. a Hanning function, a Raised Cosine function or a Taylor function for example.

It will be appreciated that it is practicable for a planar array only to apply a height taper function in one dimension and accordingly in order to reduce sidelobes in an orthogonal dimension, an amplitude taper may be applied in this direction using known techniques. It has been found however that since the array shape already provides a degree of tapering in this dimension the range of amplitude taper required is quite small and much less than would be required for -a conventionally shaped array and thus the efficiency reduction is correspondingly small.

One embodiment of the invention will now be described by way of example with reference to the accompanying drawing, in which;

Figure 1 is a somewhat schematic plan view of a planar radar array comprising a plurality of elements each of which is shown.

Referring now to Figure 1, a planar radar array comprises a plurality of elements 1 arranged to define in combination a coordinate array of rows and columns of elements. The height of the elements in a vertical direction x, as determined by the number of elements 1 in each column, is varied along the length y of the array to define a taper which extends symmetrically on each side of a centre line indicated by an arrow 2. The number of the elements 1 in each column of the array may be calculated in accordance with a Hanning, or a Taylor function for example in a similar manner to the manner in which weighting coefficients would be calculated in known systems.

With the arrangement shown in Figure 1, low sidelobes are achieved in a horizontal plane along the length y by tapering the height of the array in the vertical direction x.

Amplitude weighting either side of the centre line 2 may be applied so that the amplitude of signals to each side of the centre line 2 is reduced whereby a reduction of sidelobes in the vertical plane is also achieved. Each radiating element will be fed via an associated phase shifter and appropriate strip line networks to provide beam steering and beam formation.

In accordance with one embodiment of the invention a planar array as hereinbefore described may be embodied in one or more sides of an aircraft and thus the substrate which supports the elements of the array may form part of an aircraft superstructure.

It will be appreciated by those skilled in the art, that the elements 1 of the array as shown in Figure 1 may comprise any known form and for example may comprise shaped radiator pads, raised studs, miniature dipoles or radiating cavities. It will also be appreciated that various modifications may be made to the arrangement hereinbefore described without departing from the scope of the invention and for example amplitude modulation in one plane may be achieved by means of attenuators, dividers or power combiners which may form a part of, or which may be included in, strip lines associated with each antenna.

Claims

1. A phased array radar antenna which comprises a structure which serves to support a co-ordinate array of uniformly spaced radiating elements, wherein the height of the array along one axis thereof is tapered away from the centre of the array, thereby to afford a reduction of sidelobes in a plane orthogonal to the said one axis.

2. A phased array radar antenna as claimed in claim 1, wherein the tapering is arranged to be uniform about the array centre along one axis thereby to produce an array which is symmetrical about the array centre along the said one axis.

3. A phased array radar antenna as claimed in claim 1 or claim 2, wherein the element spacing is arranged to be at approximately a half wavelength.

4. A phased array radar antenna as claimed in any preceding claim, wherein the height of the array along the said one axis thereof is determined in accordance with a Hanning or similar taper function (eg Taylor or raised cosine).

5. A phased array radar antenna as claimed in any preceding claim, wherein an amplitude taper function is produced across the array in a direction orthogonal to the said one axis.

6. A phased array radar antenna as claimed in any preceding claim substantially as hereinbefore described with reference to the accompanying drawing.

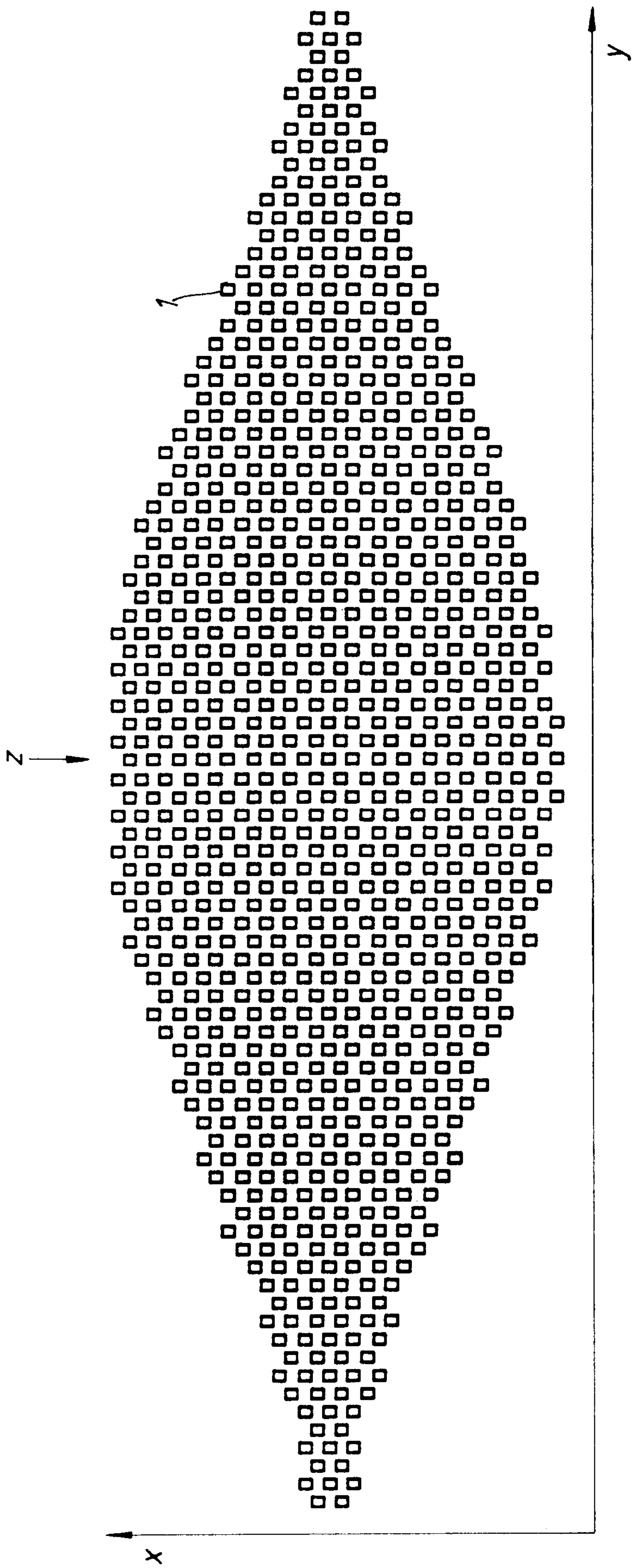

Fig.1.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 91 30 8878

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	IEEE TRANSACTIONS ON ANTENNAS AND PROPAGATION. vol. 30, no. 6, November 1982, NEW YORK US pages 1176 - 1183; LAXPATI: 'Planar Array Synthesis with Prescribed Pattern Nulls' * page 1182, right column, paragraph VII - page 1183, left column; figures 1-14 *	1,2,6	H01Q21/22 H01Q21/06
A	PROCEEDINGS OF THE IEE vol. 125, no. 3, March 1978, STEVENAGE GB pages 185 - 189; F.HODJAT: 'Electronic scanning antenna using a nonuniformly-spaced planar array' * abstract; figures 3,6,8,13 *	1-6	
A	IEEE 1980 INTERNATIONAL RADAR CONFERENCE April 1980, ARLINGTON,US pages 263 - 270; SMITH: 'SPACE DENSITY TAPERED ARRAYS FOR AIRBORNE SURVEILLANCE RADAR' * page 265 *	1-6	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			H01Q

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	04 DECEMBER 1991	ANGRABEIT

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
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