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Bezeichnung der Erfindung: An improved phased array antenna system
Title of invention:
Titre de l'invention :

Klassifikation / Classification / Classement :

ENTSCHEIDUNG / DECISION
vom / of / du 14 September 1987

Anmelder / Applicant / Demandeur : Western Electric Company, Incorporated

Patentinhaber / Proprietor of the patent /
Titulaire du brevet :

Einsprechender / Opponent / Opposant :

Stichwort / Headword / Référence :

EPÜ / EPC / CBE Article 56

Kennwort / Keyword / Mot clé : Inventive step (yes)

Leitsatz / Headnote / Sommaire

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Case Number : T 58/84

D E C I S I O N
of the Technical Board of Appeal 3.5.1
of 14 September 1987

Appellant : Western Electric Company, Incorporated
222 Broadway
New York N.Y. 10038 (US)

Representative : Blumbach Weser Bergen Kramer Zwirner Hoffmann
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Decision under appeal : Decision of Examining Division 046 dated 11.10.1983 refusing European patent application No. 80 106 499.9 pursuant to Article 97(1) EPC

Composition of the Board :

Chairman : P.K.J. van den Berg

Members : W.J.L. Wheeler

P. Ford

Summary of Facts and Submissions

I. European patent application No. 80 106 499.9 filed on 23 October 1980 (publication No. EP-A-0 028 018) claiming priority from a prior application of 24 October 1979 (US 87746) was refused by the decision of the Examining Division 046 of the European Patent Office dated 11 October 1983. That decision was based on Claims 1 and 2 filed on 2 July 1983.

II. The reason given for the refusal was that the subject-matter of the claims did not involve an inventive step having regard to the prior art disclosed in JP-A-524 145 and the common general knowledge in the art.

III. The Appellant lodged an appeal against this decision on 8 December 1983. The appeal fee was paid on the same day. The Statement of Grounds was filed on 3 February 1984.

IV. After some correspondence between the Board and the Appellant, oral proceedings were held on 14 May 1987 at the Appellant's request, at the end of which the Appellant was given a time limit of four months in which to submit amended claims and description.

V. New claims and new pages of description were received from the Appellant on 11 July 1987 with a request for the grant of a patent on the basis of the following documents:

Claims 1 and 2 filed with the letter of 8 July 1987 (received 11 July 1987);

Description, pages 1, 2, 3, 3a and 3b filed with the letter of 8 July and pages 4 to 8 as originally filed; Drawings, sheets 1/4 to 4/4 as originally filed.

VI. Claim 1 reads as follows:

1. Phased array antenna comprising:

- a plurality of curved reflectors (10, 12) arranged in tandem and confocally along the antenna feed axis, the focal point of at least one reflector being in real form and being disposed between two consecutive reflectors (10, 12),

- a feedhorn array (14) disposed in an image plane of the antenna aperture capable of launching a beam forming with the reflectors (10, 12) a main lobe and a plurality of associated grating lobes,

characterized by the features:

- a spatial filter (18) is arranged relative to the reflectors (10, 12) to substantially block the grating lobes, the spatial filter (18) being in the form of a centrally apertured stop (17) and located at said real focal point, and

- the width of the central aperture (19) of said stop being dimensioned to pass the main lobe and to substantially block the grating lobes.

Claim 2 is dependent.

Reasons for the Decision

1. The appeal complies with Articles 106 to 108 and Rule 64 EPC and is, therefore, admissible.

2. The current version of the claims and description does not extend the subject-matter of the application beyond the content of the application as filed. Therefore no objection arises under Article 123(2) EPC.

3. A phased array antenna in accordance with the prior art portion of Claim 1 is known from the text book "Antenna Theory" by Collin and Zucker, which was cited by the Appellant in the Statement of Grounds. This book, published in 1969, will be referred to as document D1. The antenna shown in Fig. 17.6 on page 51 of D1 and described in the paragraph above it has all the features shown in Fig. 1 of the present application except for the spatial filter 18.

The Board accepts that at the priority date of the present application it was generally known in the art that a feedhorn array produces in addition to the main lobe of radiation a plurality of undesired side lobes and grating lobes.

4. The problem underlying the present invention is to provide a simple means for suppressing grating lobes in phased array systems, without excessive degradation in performance.

The invention solves this problem by means of a spatial filter in the form of a centrally apertured stop located at the real focal point, the width of the central aperture of said stop being dimensioned to pass the main lobe and to substantially block the grating lobes.

5. Various means for reducing side lobes and grating lobes were known at the priority date of the present application, including spatial filters (US-A-4 021 812 and US-A-4 169 268) placed directly in front of the feedhorn array. There

is, however, no explicit disclosure in any of the prior art documents cited in the present case of a spatial filter in combination with a phased array antenna in accordance with the prior art portion of Claim 1.

An antenna was known from JP-A-524 145 (which was laid open 13.01.77 and will be referred to as D2) in which an apertured screen (2) is arranged with the aperture (3) at the real focal point (F) of the main reflector (1) of the antenna between the main reflector (1) and a subreflector (4) which converges the radiation passing through the aperture (3) into a single feedhorn (5). The purpose of the screen (2), as explained in D2, is to block disturbing radiation, such as that scattered by a raindrop at point P shown in Fig. 1, 2 and 3. (The basis for the Board's interpretation of D2 is the English language abstract appearing in Patents Abstracts of Japan, Vol. 1, No. 63, page 290 E 77 and an unofficial translation of D2, filed by the Appellant in the proceedings before the Examining Division).

Since the antenna known from D2 does not include a feedhorn array, the problem of grating lobes does not arise. The problem of side lobes could arise but D2 does not mention it. Nor does D2 give much indication of the dimensions of the aperture (3) other than that it is "small" and may be a slit "small in width but long in one direction."

6. The question which has to be answered in this case is: would a person skilled in the art have realised that the apertured screen disclosed in D2 blocked, or could be adapted to block, side lobes, since, if he realised it could be used for this, it would be obvious to him that it could also be used to block grating lobes in a phased array antenna of the type defined in the prior art portion of Claim 1.

A number of factors pointing to a negative answer to this question were explained on behalf of the Appellant at the oral proceedings. First of all, side lobes and grating lobes result from the structure of an antenna. D2 is concerned solely with an environmental problem, not related to the structure of the antenna per se. Second, if the inventor of D2, who must be assumed to be skilled in the art, had realised his apertured screen blocked side lobes, he would have said so.

D2 is concerned mainly with the problem of reducing interference from waves scattered by rain droplets (see translation of D2, page 2, line 12 to page 3, line 1, and page 3, line 28 to page 4, line 1). The explanation given in D2 is rather simplified, since, in practice, interference will not come from a single rain droplet at a single fixed point P, but will be the result of multiple scattering from a large number of rain droplets whose positions are always changing. Without the screen (2) it would be possible for waves to be scattered in zigzag paths into the horn (5) without being reflected from either of the reflectors. The screen (2) cooperates with the subreflector (4) to ensure that only those waves which travel through the aperture (3) in the desired direction (i.e. within the angle α) are focussed into the horn (5). Waves selected in this way will remain substantially free from interference by scattering since there will be no rain droplets below the screen (2).

In the opinion of the Board, a person skilled in the art would think that the screen (2) in D2 had been designed specifically to solve the problem of multiple scattering by rain droplets, since any incoming waves, which, in the absence of scattering by rain droplets, are such as not to

be focused by the main reflector (1) at its focal point (F), would not be focused by the subreflector (4) into the horn (5). In other words, the skilled person would not think the screen (2) provided any additional discrimination against off-boresight waves over and above that provided by the reflectors (1) and (4).

The Board therefore considers it unlikely that a person skilled in the art, seeking a means to suppress side lobes and/or grating lobes, would have considered D2 to have been of any assistance to him.

The prior art spatial filters known from US-A-4 021 812 and US-A-4 169 268 were relatively complicated and placed directly in front of the feedhorn array, i.e. at a point in the system where the grating lobes are actually present. The present invention adopts a different approach to the problem, by providing a simple apertured stop at the focal point, i.e. at a point in the system where the lobes are not actually present.

The simplicity of the present invention compared with these prior art filters is a further indication that the present invention was not obvious, especially as there had been a lot of activity in this field in search of a solution to the problem of grating lobes.

In view of the above considerations, the Board holds that the subject-matter of Claim 1 is not obvious to a person skilled in the art, having regard to the state of the art, and it is therefore considered as involving an inventive step (Article 56 EPC).

Claim 1 and dependent Claim 2, relating to a particular embodiment, are therefore allowable.

7. Since the only ground for refusal, lack of inventive step, is no longer valid, the decision under appeal must be set aside.

8. However the patent sought cannot be granted immediately since the substantive examination has not yet been completed as far as the description is concerned. The Board acknowledges that the Examining Division had no reason to do this, as they were going to refuse the application for lack of inventive step of the claimed subject-matter. In particular, the statements on page 4, lines 7 and 8 and lines 28 to 33, and on page 5, lines 21 to 23 are inconsistent with the claims.

Order

For these reasons, it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to grant a patent on the basis of the following documents:

Claims 1 and 2, received 11 July 1987;

Description, pages 1, 2, 3, 3a and 3b received 11 July 1987 and pages 4 to 8 as originally filed, the description to be amended as the Examining Division thinks fit to remove inconsistencies (see point 8 of the reasons for the decision) and correct clerical errors;

Drawings, sheets 1/4 to 4/4 as originally filed.

The Registrar: The Chairman:

F. Klein P.K.J. van den Berg