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D E C I S I O N
of 2 May 2001

Case Number: T 0905/00 - 3.5.1

Application Number: 97106646.9

Publication Number: 0805511

IPC: H01Q 5/00

Language of the proceedings: EN

Title of invention:
Dual frequency feed horn for an antenna

Applicant:
TRW INC.

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 123(2), 56

Keyword:
"Added subject-matter (no)"
"Inventive step (no)"

Decisions cited:
-

Catchword:
-

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Case Number: T 0905/00 3.5.1

D E C I S I O N
of the Technical Board of Appeal 3.5.1
of 2 May 2001

Appellant: TRW INC.
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 28 April 2000 refusing European patent application No. 97 106 646.9 pursuant to Article 97(1) EPC.**

Composition of the Board:

Chairman: A. S. Clelland
Members: R. S. Wibergh
H. Preglau

Summary of Facts and Submissions

I. This appeal is against the decision of the examining division to refuse application No. 97 106 646.9 on the ground that the subject-matter of the independent claim of both a main and an auxiliary request lacked an inventive step. The refusal was based on the disclosure of the following documents:

D5: US-A-5 258 768

D6: FR-A-2 651 071.

II. The appellant (applicant) lodged an appeal against this decision and paid the prescribed fee. In the subsequently filed statement of grounds the appellant argued that the claims rejected by the examining division were inventive, in particular with regard to the disclosure of document D6, and maintained both requests. An auxiliary request was made for oral proceedings.

III. In a communication from the Board reference was made to textbooks which were considered to be standard textbooks in the antenna art. *Inter alia* the following passages were cited:

D7: "Antenna Engineering Handbook", 3rd edn., Ed R. Johnson, McGraw-Hill 1993, pages 18-16 and 18-17

D9: "Radar Handbook" 2nd edn., ed. Skolnik, McGraw-Hill 1990, pages 6.40 and 6.41

IV. In response, the appellant filed revised claims of a new main request and of first and second auxiliary requests. It was argued that the independent claim of each request was inventive having regard to the disclosure both of documents D5 and D6, and D7 and D9.

V. Oral proceedings were held on 2 May 2001. In the course of the oral proceedings the appellant made further amendments to the claims. The **main request** as considered by the Board was for grant of a patent on the basis of the following documents:

Claims: 1 to 6 as filed at the oral proceedings; 7 to 12 as filed on 2 April 2001.

Description: pages 2a, 2b and 3 as filed on 2 April 2001; pages 1, 2, 4 and 5 as filed on 10 June 1999; and pages 6 to 15 as originally filed.

Drawings: sheets 1/3 to 3/3 as originally filed.

The **first auxiliary request** replaces the above claims by claims 1 to 6 as filed in the course of the oral proceedings and claims 7 to 12 as filed on 2 April 2001. The **second auxiliary request** replaces the above claims by claims 1 to 4 as filed in the course of the oral proceedings and claims 5 to 10 as filed on 2 April 2001.

VI. Claim 1 of the main request reads as follows:

"A steerable microwave antenna assembly for a space satellite, comprising:

a microwave reflector (1) having a curved surface defining a focal point and a predetermined focal length;

support means (13, 15) for mounting to said space satellite;

positioning means (7, 9) coupled to said microwave reflector (1) for positioning the attitude and elevation of said microwave reflector (1) over a predetermined hemisphere, said positioning means being mounted at a first location stationary in relation to said support means, whereby said microwave reflector (1) is positioned in attitude and elevation about said first location;

a feed horn (3), said feed horn being electromagnetically coupled to said microwave reflector (1) for transmission of microwave energy therebetween and being mounted at a second location stationary in relation to said support means (13, 15, 21) to maintain the position of said feed horn (3) stationary relative to said first location, wherein said microwave reflector (1) is adjustable in directional orientation by said positioning means independently of said feed horn (3); and

said feed horn (3) including a first end oriented facing said curved surface of said microwave reflector (1);

characterized by

a bracket (21) serving to maintain the relative horizontal distance between the feed horn and the positioning means mounting position fixed and the axial distance along the feed horn axis and the reflector fixed, said bracket (21) supported on said support means (13, 15) and including a bracket portion spaced from said support means (13, 15);

said positioning means (7, 9) being mounted at

said first location along said bracket (21);

said feed horn (3) being mounted at said second location along said bracket portion spaced from said support means (13, 15); and

said feed horn (3) not being positioned at the reflector's focal point.

VII. Claim 1 of the first auxiliary request differs from the above claim only in respect of the final feature, which reads as follows:

"said first end of said feed horn (3) being located more proximate said curved surface than said focal point, in any attitude and elevation orientation of said curved surface."

VIII. Claim 1 of the second auxiliary request reads as follows:

"A steerable microwave antenna assembly for a space satellite, comprising:

a microwave reflector (1) having a curved surface defining a focal point and a predetermined focal length;

a platform (15) for mounting to said space satellite; a container (13), said container being of a predetermined height, having top and bottom surfaces and being fixed to an upper surface of said platform (15) with said bottom surface of said container abutting said platform (15), whereby said top surface of said container (13) is elevated in position above said upper surface of said platform (15);

a bracket (21) serving to maintain the relative horizontal distance between the feed horn and the positioning means mounting position fixed and the axial

distance along the feed horn axis and the reflector fixed, said bracket (21) including a first portion positioned overlying said top surface of said container (13) and a second portion extending at an incline from said top surface of said container (13) to a laterally spaced position located on said platform (15) and underlying said top surface of said container (13), wherein both said bracket (21) and said container (13) are supported upon said platform (15);

positioning means (7, 9) coupled to said microwave reflector (1) for positioning the attitude and elevation of said microwave reflector (1) over a predetermined hemisphere, said positioning means being mounted at a first location on said first portion of said bracket (21) stationary in relation to said container (13), whereby said microwave reflector (1) is positioned in attitude and elevation about said first location;

a feed horn (3), said feed horn being electromagnetically coupled to said microwave reflector (1) for transmission of microwave energy of a first and a second frequency therebetween and being mounted at a second location on said second portion of said bracket (21) in relation to said support means (13, 15, 21) to maintain the position of said feed horn (3) stationary relative to said first location, wherein said microwave reflector (1) is adjustable in directional orientation by said positioning means independently of said feed horn (3);

said feed horn (3) including a first end oriented facing said curved surface of said microwave reflector (1); and

said first end of said feed horn (3) being located more proximate said curved surface than said focal point in any attitude and elevation orientation of said

curved surface."

Reasons for the Decision

1. *Added subject-matter (Article 123(2) EPC)*

1.1 In the course of the oral proceedings the wording of claim 1 of both the main and first auxiliary requests as filed in response to the Board's communication was the subject of discussion as to Article 123(2) EPC. In consequence of these discussions the appellant asked for, and was granted, permission to amend claim 1 of these two requests in order to avoid objection that the claims went beyond the disclosure of the application as filed.

1.2 Claim 1 of the main request refers in its final feature to the feed horn "not being positioned at the reflector's focal point". This wording corresponds in substance to the originally filed description at page 7, lines 24 to 27, in which it is stated that a scan loss occurs "due to the fact that the feed horn is or becomes displaced from the focal point of the reflector".

1.3 The final feature of claim 1 of the first auxiliary request now states that the first end of the feed horn is located more proximate the curved surface of the reflector than the reflector's focal point, "in any attitude and elevation orientation of said curved surface". The Board understands this to mean that the prime focus of the reflector is within the mouth of the feed horn. This is disclosed by claim 10 as originally filed, which referred to the feed horn end being

located "more proximate said concavely shaped surface than said focal point irrespective of the orientation of said curved surface".

1.4 The Board accordingly concludes that the independent claims of the main and first auxiliary requests do not give rise to objection of added subject-matter.

2. *Inventive step (main request)*

2.1 The application relates to a problem which occurs in steerable microwave antennas mounted on space satellites. In order to make prior art antenna assemblies steerable the entire assembly, comprising a parabolic reflector, a feed horn and the associated electronics are mounted on a platform which is moveable by means of a gimbal system. The known arrangement is however heavy, the mass and momentum requiring a heavy duty gimbal system and an appropriate caging structure to handle launch vibration. In the application this problem is said to be overcome by fixedly mounting the feed horn and electronics box while moving the reflector to achieve the necessary steering.

2.2 The use of reflector tilt in order to achieve beam steering is common general knowledge in the antenna art, see document D7 at pages 18-16 and 18-17. A specific antenna making use of such steering is known from document D5, which discloses at Figures 1 and 2 a steerable microwave antenna assembly for a space satellite, comprising a parabolic microwave reflector and a feed horn electrically coupled to the reflector. In accordance with column 3, lines 4 to 12 the feed horn is "fixedly mounted to a structure (not shown) and the antenna beam is scanned by movement of the

reflector 18" relative to the feed horn. No further details of the mounting or scanning are given. From this passage the Board understands that the assembly, which is stated at column 2, lines 45 and 46 to be "useable in an earth orbital environment" is mounted by some form of support means on a satellite and is provided with undisclosed positioning means coupled to the parabolic reflector for positioning the attitude and elevation of the microwave reflector.

2.3 Turning now to claim 1 of the main request, the claim includes various details of the support provided for the reflector and the feed horn, which in essence come down to the provision of a bracket with the feed horn mounted at one end and the reflector positioning means mounted at the other. The claim further includes the feature of the feed horn "not being positioned at the reflector's focal point".

2.4 Dealing with this latter point first, defocussing would appear to be a logical consequence of tilting the reflector, since the focal point is moved away from the feed horn phase centre; it is therefore of no additional limitative effect and is necessarily present in the D5 antenna assembly.

2.5 The question of inventive step thus devolves to the question of whether the skilled person, putting the teaching of D5 into effect, would mount the feed horn and the reflector positioner at opposite ends of a bracket. The appellant argued that the skilled person would not arrive at the specific mechanical structure of the claim. Although the skilled person would be aware of the need for mechanical stability to counteract launch vibration and to provide the

necessary accuracy in the electrical path, there were a number of solutions to the problem; for example, it would be possible to ensure the necessary positioning of the feed horn and reflector positioning means by mounting each on the satellite separately. D5 gave no hint as to how the relative spacing was to be achieved and no other document even hinted at the claimed solution.

2.6 The Board however considers that mounting the components separately on the satellite surface would have disadvantages which would discourage the skilled person from adopting this solution. In particular, if there were no fixed relative spacing between the feed horn and the positioner it would not be possible to carry out pre-launch testing of the antenna unless it were mounted on the satellite. There are therefore good reasons why the skilled person would create a modular assembly, comprising the feed horn, the positioner and the parabolic reflector. Reference is directed to D9, which in the passage bridging pages 6.40 and 6.41 makes clear that in a mechanically scanned reflector antenna accurate relative mounting of the feed horn and the reflector is essential; the passage states that "In most cases, the mechanical design of an antenna requires greater engineering effort and innovation than does the relatively simple electrical (RF) design". In the Board's view the only practical method of ensuring accurate relative positioning of on the one hand the feed horn and on the other the reflector/positioner assembly so as to obtain reproducible test results is to mount them on a common platform; or, in different language, to mount them at opposite ends of a bracket. The Board accordingly considers that the skilled person, implementing the D5 design would without the

exercise of invention arrive at the antenna assembly which is the subject of claim 1 of the main request.

3. *Inventive step (first auxiliary request)*

3.1 Claim 1 of the first auxiliary request only differs from that of the main request in that the "first end" of the feed horn, ie the outer rim is "located more proximate said curved surface than said focal point, in any attitude and elevation". In other words, whatever the attitude and elevation of the reflector, its focal point is located within the horn. However, as was accepted by the appellant, the phase center of a horn is within the horn throat, so that in a standard horn-reflector system in which the horn phase center and reflector focal point coincide, the horn rim or "first end" will always be between the reflector and its focal point. The appellant argued that even if this was the case, it did not follow that where the antenna was steered by tilting the reflector the condition would still be met. If the reflector were tilted enough the arc described by the focal point would intersect the plane containing the feed horn rim and no longer meet the condition. This, whilst possibly true, is of no practical consequence since the degree of rotation of the reflector to achieve this condition would be such that the antenna would be completely defocussed. The Board accordingly concludes that in any practical system the condition specified is met.

3.2 Since the remaining features of claim 1 of the first auxiliary request are identical to those of claim 1 of the main request, it follows that the above discussion on the main request applies *mutatis mutandis* to this request also. The subject-matter of claim 1 of the

first auxiliary request accordingly does not involve an inventive step.

4. *Inventive step (second auxiliary request)*

4.1 Claim 1 of this request adds to claim 1 of the first auxiliary request the provision of a platform for the antenna assembly, the platform having mounted on it a container with the bracket mounted at an inclined position with one end on the top surface of the container and the other end on the platform; the reflector positioning means are mounted at the end overlying the container and the feed horn at the other end.

4.2 It was argued by the appellant that the prior art gave no hint which would lead the skilled person to the specific configuration claimed. This configuration was particularly compact and robust, the use of the electronics container as a support for the bracket permitting particularly short electrical connections to the antenna and a robust and stable structure. The antenna, which thus extended into three dimensions, could nevertheless be maintained dimensionally stable and less temperature sensitive than merely mounting it on a fixed two-dimensional support.

4.3 The Board notes that the claim does not in fact specify that the container contains the antenna electronics. The claim therefore in essence adds to claim 1 of the first auxiliary request that one end of the antenna assembly is mounted on a box. Since as previously noted any practical antenna assembly will be modular, ie mounted on its own support, it is open to the skilled person to mount the assembly in any convenient manner.

No exercise of inventive skill would appear to be involved in the choice of an inclined bracket as specified in the claim and no unexpected advantage appears to arise from such a bracket. The Board accordingly concludes that the subject-matter of claim 1 of the second auxiliary request lacks an inventive step.

5. There being no other requests, it follows that the appeal must be dismissed.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

M. Kiehl A. S. Clelland