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(71) Applicant: **Rac S.r.l.**
20154 Milan (IT)

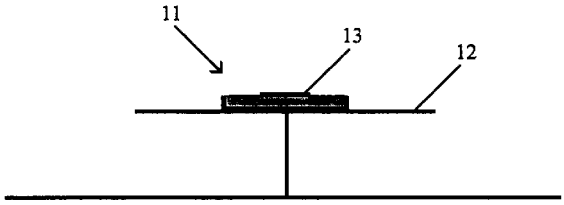
(72) Inventor: **Pinton, Orfeo G.**
20135 Milan (IT)

(74) Representative:
De Gregori, Antonella
Ing. Barzano & Zanardo Milano S.p.A.
Via Borgonuovo 10
20121 Milano (IT)

(54) Multiple-antenna structure, in particular for satellite and ground installations

(57) A multiple-antenna structure (11), in particular for satellite and ground installations, of the type having at least one output and if necessary provided with external protection, comprising at least one first radiating element (12) and at least one second radiating element (13) designed to operate substantially in different frequency bands, the first radiating element (12) and the second radiating element (13) being electromagnetically decoupled from one another and having radiation planes which are substantially mutually perpendicular.

Fig.1



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Description

[0001] The present invention relates to a multiple-antenna structure, in particular for satellite and ground installations.

[0002] During recent years there has been an extremely rapid expansion in the communications sector, and in particular the radio communications sector, as regards not only ground-based installations but also satellite installations.

[0003] Ground or ground-based installations, in addition to a very extensive distribution network, are able to count upon a very large number of users and a transmission signal which is of high quality within the confines of the areas where there is radio coverage.

[0004] Satellite installations, on the other hand, which are currently going through a period of extremely rapid growth, are able to achieve a coverage far greater than that of ground installations, to the detriment, however, of the signal quality.

[0005] It is known that the antennas for ground-based installations must have a radiation pattern which is omnidirectional on a horizontal plane, so as to receive the same signal level, irrespective of the direction of travel of the mobile station relative to the base station, whereas, on the vertical plane, the antenna must have maximum gain on the horizon and zero gain at the zenith. Polarization of the antenna for ground-based installations must be vertical. The frequency bands used in this type of application are typically VHF or UHF frequency bands, with variable antenna gain and bandwidths.

[0006] On the other hand, the antennas for satellite installations must have a semi-spherical radiation pattern, preferably without secondary lobes, and with a clear cut-off at an elevation of 10 degrees. In this way all the satellites above the horizon are visible, except for those with an elevation of less than 10 degrees. The amplitude response must be constant over the entire coverage area so that the signal received by the satellites has the maximum signal-to-noise ratio. The frequency band used is, at present, the so-called "L band", although projects which use the "S band" are being developed. The bandwidth depends on the particular type of installation.

[0007] As is well-known, in order to be able to use radio communication installations which operate at different frequencies, in particular in order to be able to use a satellite installation and a ground installation at the same time, it is necessary to install two antennas, each suitably constructed so as to operate with a given installation. Moreover, for correct operation without undesirable disturbances affecting the field of each antenna, said antennas must be installed in zones without protruding metal objects. In particular, the antennas must be mounted at a distance from one another so as to avoid mutual interference; this makes it impossible to install simultaneously two antennas in small areas, making the design and construction of the installations which use these antennas extremely difficult. For example, if a mobile antenna for ground-based installations in the UHF band were to be installed in the vicinity of a satellite antenna, on account of its high transmission power, the satellite antenna could be blacked out by it or, in the most serious of cases, the amplification stage could be damaged.

[0008] The object of the present invention is that of eliminating the drawbacks mentioned, by providing a multiple-antenna structure, in particular for satellite and ground installations, which can be used so as to work together with communication installations operating at different frequencies, in particular so as to be able to use simultaneously a satellite installation and a ground-based installation.

[0009] Another object of the invention is that of providing a multiple-antenna structure, in particular for satellite and ground installations, which can be easily installed also in small areas, without the radiating elements, which operate at different frequencies, influencing each other such that they are disturbed and/or damaged.

[0010] Finally, an equally significant object of the invention is that of providing a multiple-antenna structure, in particular for satellite and ground installations, which is simple, safe, reliable and relatively low-cost.

[0011] These and other objects, according to the present invention, are achieved by providing a multiple-antenna structure, in particular for satellite and ground installations according to Claim 1, to which reference should be made for the sake of brevity.

[0012] Further characteristic features and advantages of a multiple-antenna structure, in particular for satellite and ground installations, according to the present invention, will emerge more clearly from the following description, provided by way of a non-limiting example, with reference to the accompanying schematic drawings, in which:

Figure 1 is a schematic view of an antenna according to the invention;
Figure 2 shows a radiation diagram, in the horizontal plane, of a first radiating element of the antenna;
Figure 3 shows a radiation diagram, in the vertical plane, of the first radiating element of the antenna;
Figure 4 shows a radiation diagram, in the horizontal plane, of a second radiating element of the antenna;
Figure 5 shows a radiation diagram, in the vertical plane, of the second radiating element of the antenna.

[0013] With reference to the said figures, a multiple-antenna structure, in particular for satellite and ground installations, indicated in its entirety by the number 11, is shown.

[0014] Below, in particular, a multiple-antenna struc-

ture 11, developed for mobile communications with ground-based installations in the VHF or UHF frequency band, and for GPS satellite installation in the "L band", will be described.

[0015] An installation of this type has been chosen owing to its particular complexity compared to other similar cases, said complexity being due to the stringent characteristics in the radiation diagram of the receiving antennas required by the GPS installation, necessary for ensuring the considerable precision which is required when determining the position of a user.

[0016] The antenna structure 11 comprises a first radiating element 12 in the VHF/UHF band and a second radiating element 13 in the L band, which have radiation planes perpendicular to one another. In a preferred but non-limiting embodiment, the decoupling between these radiating elements 12, 13 is greater than 100 dB.

[0017] The first radiating element 12 consists, for example, of a disk-type antenna which has radiation patterns in the horizontal plane and vertical plane shown in Figures 2 and 3. The radiating element 12 is polarized vertically and, as can be seen from Figures 2 and 3, the power is emitted, in the horizontal plane, in a manner which is uniform in all directions and, therefore, constant upon variation of an angle Φ. In the vertical plane, however, the power is maximum in a direction defined by an angle $\theta = 90$ and is zero in a direction defined by an axis Z corresponding to the angle $\theta = 0$. The radiating element 12 operates, for example, in a frequency band of 30-1000 MHz. The disk-type radiating element is known per se and therefore will not be further described in more detail below.

[0018] The second radiating element 13 is of the patch type and has radiation patterns in the horizontal and vertical planes shown in Figures 4, 5.

[0019] The radiating element 13 must emit/receive with polarization dependent on the installation in question, but in any case uniformly in the hemisphere above the horizon. Therefore the radiation diagram must be semi-spherical with a maximum gain in the direction defined by the axis Z and very low on the horizon. The radiating element 13 operates, for example, in a band of 1000-4000 MHz and also has linear polarization, or in a different embodiment, cross-polarization, or in a further embodiment, right-hand or left-hand circular polarization or, finally, elliptical polarization.

[0020] In order to avoid undesirable interference, the two radiating elements 12, 13 are arranged with axes which nearly coincide and so as to be positioned each in a region where the field generated by the other one is substantially zero. For this purpose, the first radiating element 12 is positioned underneath the horizon of the second radiating element 13 so that the said radiating element 13 is positioned above the radiating element 12 in a zone in which the field generated by the latter is substantially zero.

[0021] The radiating element 13 is provided, moreover, with an "LNA" amplifier with a gain of 20-40 dB and a signal-to-noise ratio of less than 3 dB.

[0022] The connection between the radiating elements is preferably provided along zero-current separation surfaces; moreover, the antenna structure 11 has a single output or, alternatively, two outputs. The antenna structure 11 has an external protection although, in a different embodiment, it may not have said protection.

[0023] Modifications and variations are obviously possible; thus, for example, a multiple-antenna structure, in particular for satellite and ground installations according to the invention, may be used for operating in any separate bands with radiation planes which are mutually perpendicular.

[0024] Basically it can be seen how a multiple-antenna structure, in particular for satellite and ground installations according to the invention, is particularly advantageous owing to its extreme ease of installation and owing to its small dimensions which make installation and use thereof extremely simple and flexible.

[0025] A multiple-antenna structure, in particular for satellite and ground installations thus conceived, may be subject to numerous modifications and variations, all of which fall within the invention; moreover all the details may be replaced by technically equivalent elements.

[0026] Basically the materials used, as well as the dimensions, may be of any nature according to technical requirements.

Claims

1. Multiple-antenna structure (11), in particular for satellite and ground installations, of the type having at least one output and if necessary provided with external protection, characterized in that it comprises at least one first radiating element (12) and at least one second radiating element (13) designed to operate substantially in separate frequency bands, said first radiating element (12) and said second radiating element (13) being electromagnetically decoupled from one another and having radiation planes which are substantially mutually perpendicular.

2. Multiple-antenna structure (11), in particular for satellite and ground installations, according to Claim 1, characterized in that said radiating elements (12, 13) are arranged above one another so that the field generated by said first radiating element (12) substantially does not interfere with said second radiating element (13) and vice versa, said radiating elements (12, 13) thus being physically connected and positioned with axes which substantially coincide.

3. Multiple-antenna structure (11), in particular for satellite and ground installations, according to Claim 1, characterized in that at least said first radiating ele-

ment (12) consists substantially of at least one disk-type radiating element.

4. Multiple-antenna structure (11), in particular for satellite and ground installations, according to Claim 1, characterized in that at least said second radiating element (13) consists substantially of at least one radiating element of the patch type.

5. Multiple-antenna structure (11), in particular for satellite and ground installations, according to Claim 1, characterized in that the connection between said first radiating element (12) and said second radiating element (13) is performed along zero-current separation surfaces.

6. Multiple-antenna structure (11), in particular for satellite and ground installations, according to Claim 1, characterized in that said first radiating element (12) is able to radiate in a frequency band of 30-1000 MHz.

7. Multiple-antenna structure, in particular for satellite and ground installations, according to Claim 1, characterized in that said second radiating element (13) is designed to radiate in a frequency band of 1000-4000 MHz.

8. Multiple-antenna structure (11), in particular for satellite and ground installations, according to Claim 1, characterized in that said second radiating element (13) has linear polarization or crossed polarization or right-hand or left-hand circular polarization or elliptical polarization.

9. Multiple-antenna structure (11), in particular for satellite and ground installations as described and illustrated and for the purposes specified.

Fig.1

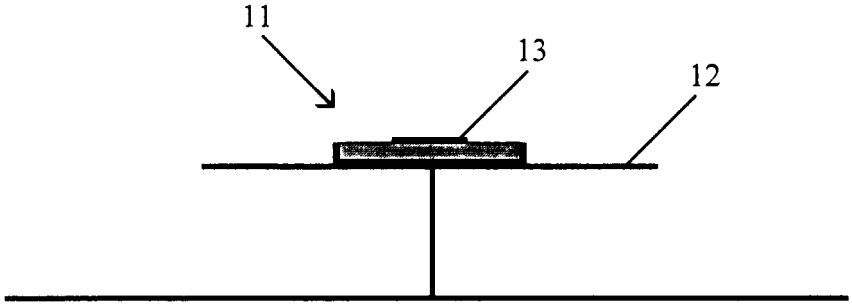


Fig.2

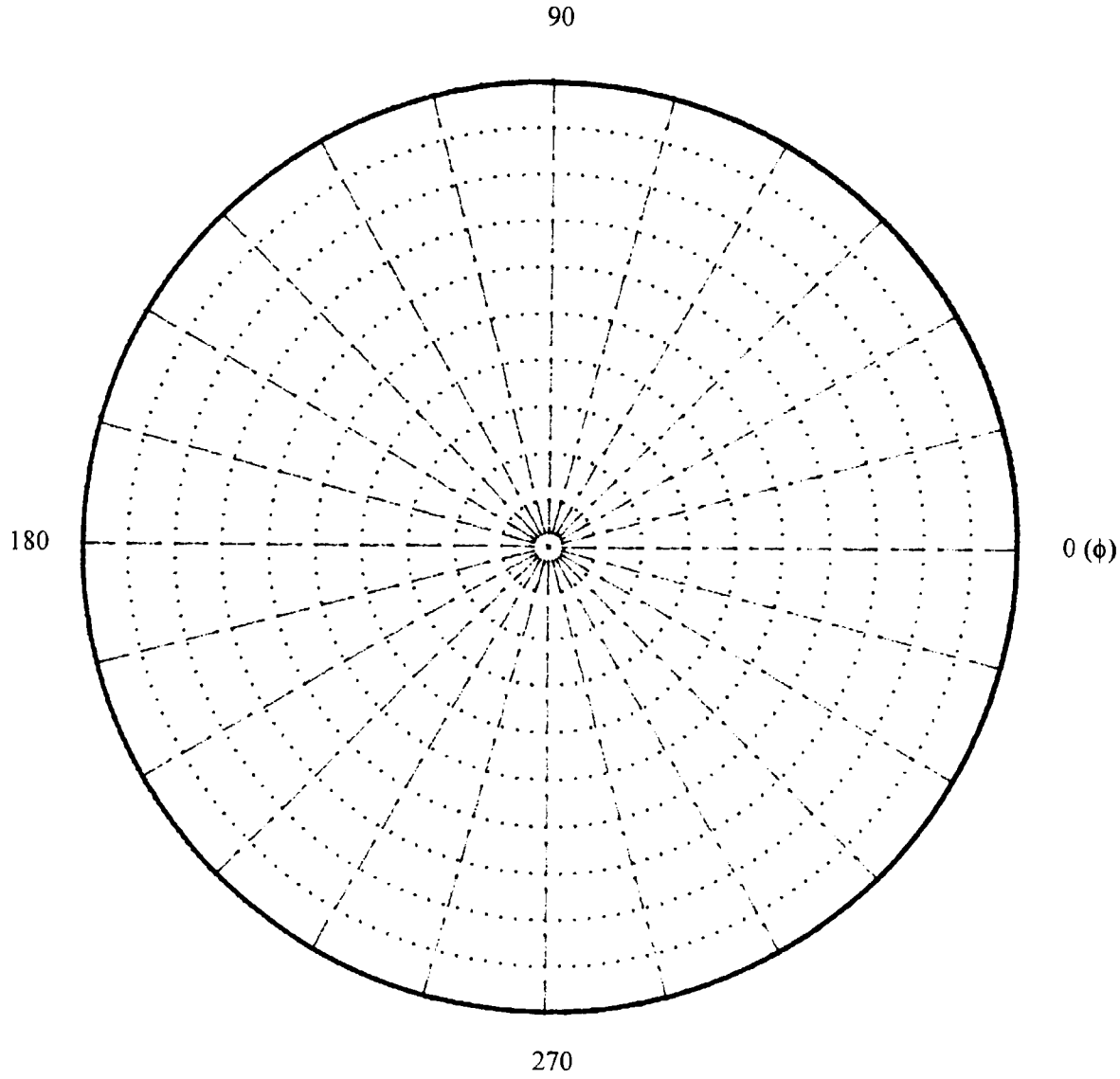


Fig.3

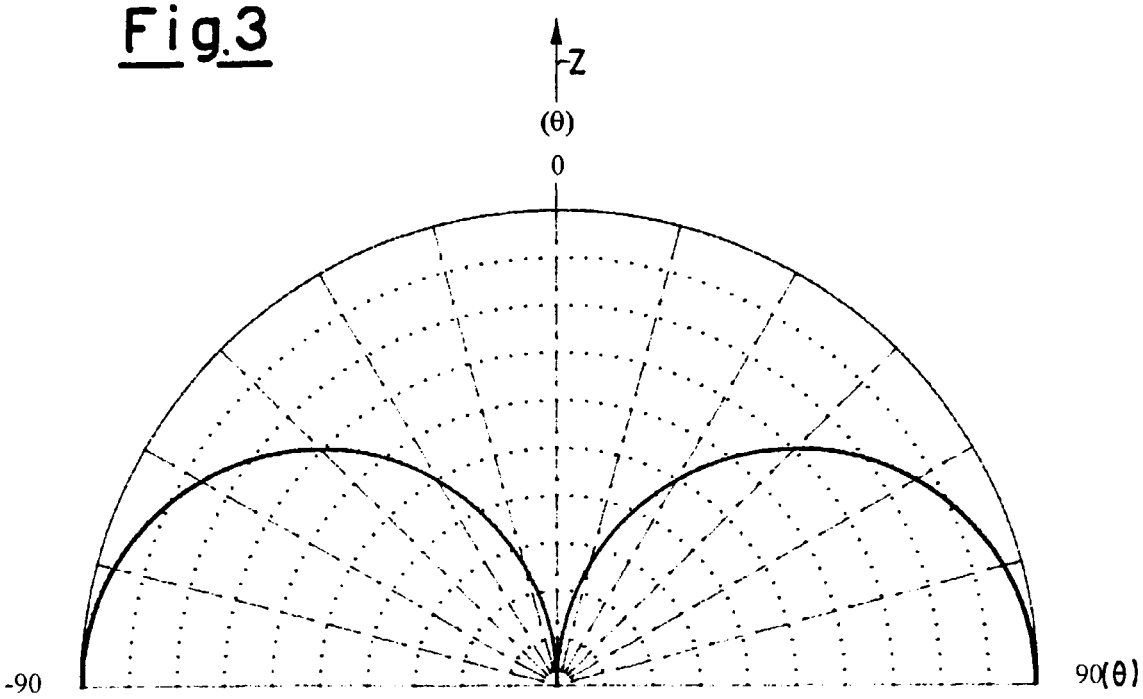


Fig.4

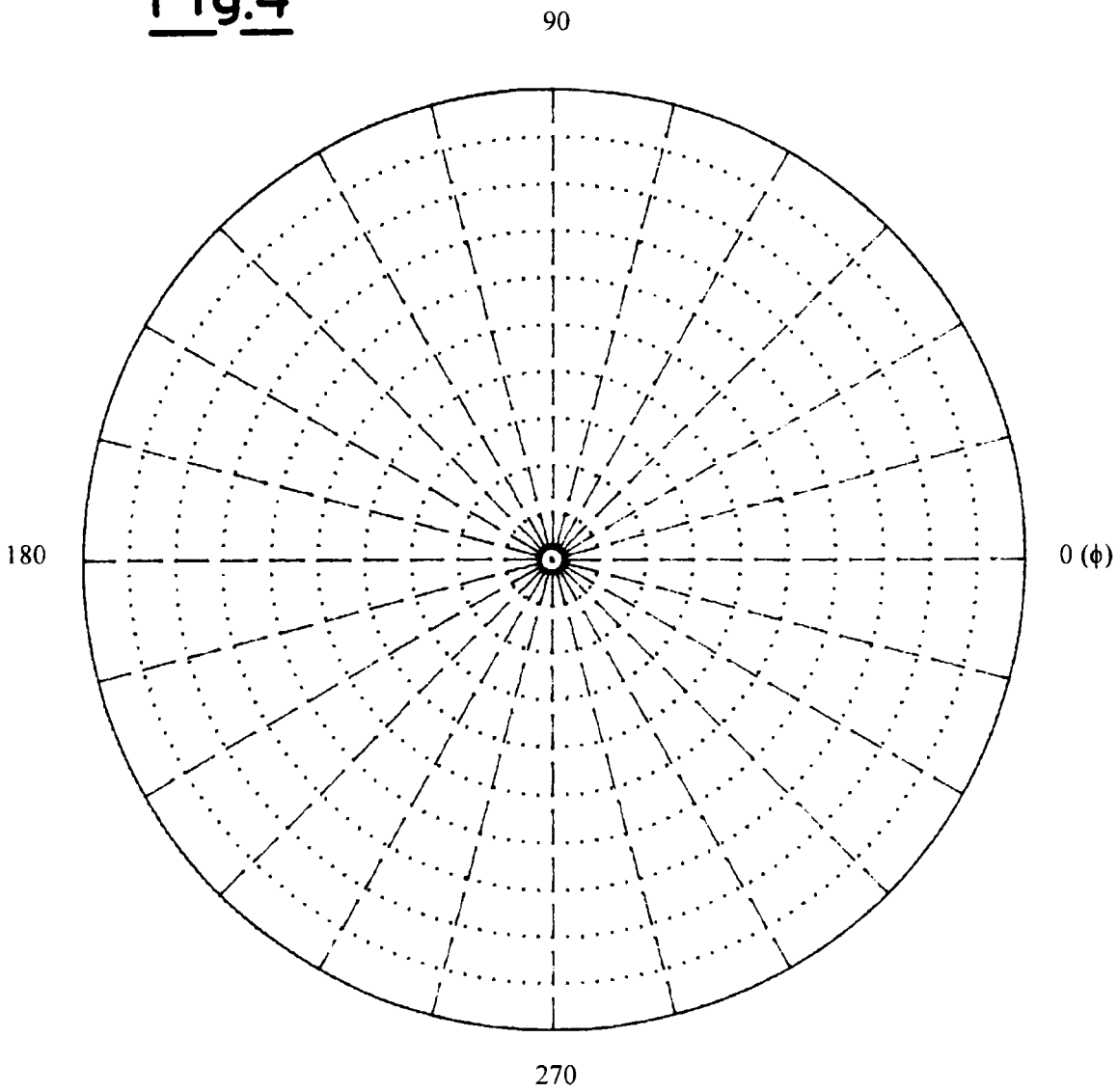
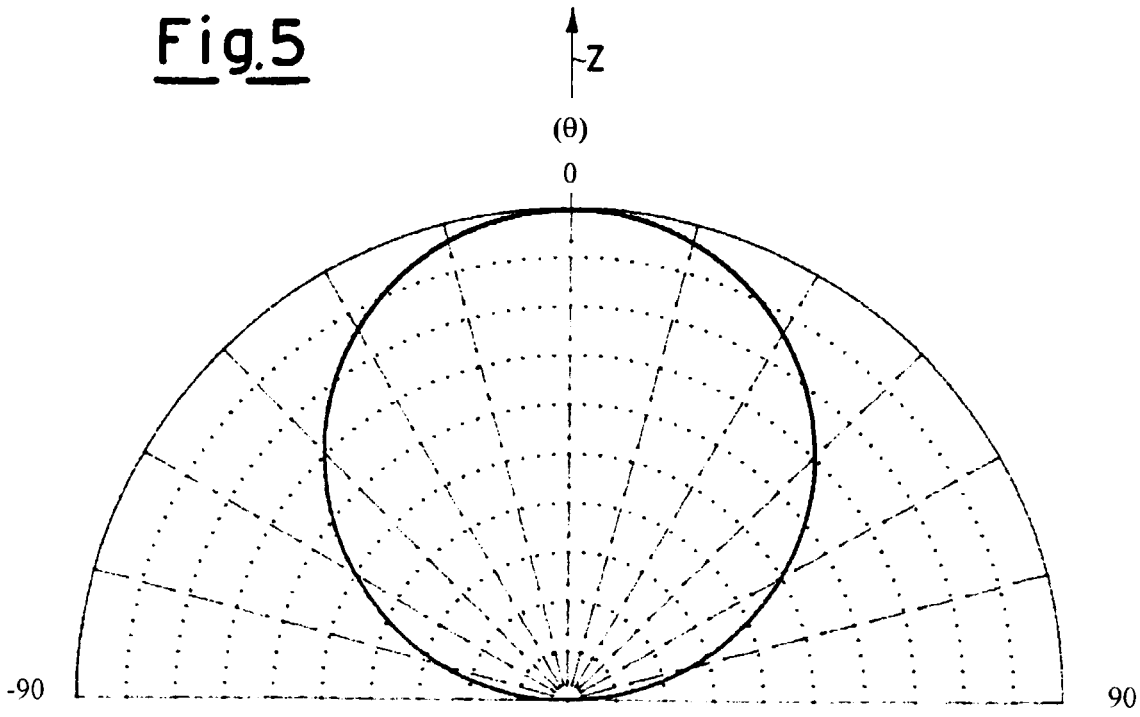


Fig.5



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EUROPEAN SEARCH REPORT

Application Number
EP 99 20 2064

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.7)
X	GB 2 272 575 A (GEC-MARCONI AVIONICS) 18 May 1994 (1994-05-18) * page 2, line 25 - page 5, line 15 * * page 5, line 27 - page 9; figure 1 *	1-9	H01Q9/04 H01Q9/36 H01Q21/28 H01Q21/30
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X	WO 96 35241 A (CENTRE-POINT TECHNOLOGY) 7 November 1996 (1996-11-07) * page 13, line 31 - page 23, line 25; figures 1-6 *	1,2,4-9	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	20 October 1999	Angrabeit, F

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