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Cavity Antenna.

The invention provides a cavity antenna (1) and is suitable, for example, for application as a communication antenna. The antenna (1) comprises a cavity (2) with dielectric (7), an aperture (4) arranged in front of the cavity (2), and a feed element (5). According to the invention, the dielectric (7) is provided with hollow spaces (14) containing electrically conducting shells (15). By introducing such a dielectric, the radar target cross-section of the antenna can be reduced and the antenna is made less space-consuming and lighter.

The present invention relates to an antenna for transmitting and/or receiving electromagnetic radiation comprising a cavity, an aperture arranged in front of the cavity, a feed element arranged in the cavity and a dielectric arranged in connection with the cavity.

Cavity antennas with a dielectric according to the above paragraph are well known to the expert in the antenna field. In this connection, reference can be made to the article by E H Newman and G A Thiele, "Some Important Parameters in the Design of T-Bar Fed Hot Antennas", IEEE Trans Ap, January 1975, in which a cavity antenna according to the above is disclosed. The measurement results shown certainly apply to an airfilled cavity but it is apparent from the article that many cavity antennas have a dielectric filling.

The cavity antennas have a directional effect and are suitable for use as communication antennas within, for example, the UHF band.

However, the known cavity antennas have a number of characteristics in common which are unwanted, at least with certain applications. Thus, it can be said that the antenna has a relatively large radar target cross-section. The large radar target cross-section is primarily caused by the corner reflectors inside the cavity. To prevent detection, it is more and more important, above all in military applications, that the equipment has the smallest possible radar target cross-section. Stealth technology is becoming more and more important in the construction of military equipment. Moreover, the antenna cavity is bulky and, in consequence, heavy.

It is the aim of the present invention to produce an antenna which eliminates, or at least reduces, the above-mentioned unwanted characteristics through its design. The aim of the invention is achieved by an antenna which is characterised by the fact that the dielectric is provided with hollow spaces and that these hollow spaces contain electrically conducting shells.

By introducing a dielectric with the specified construction, the radar target cross-section of the antenna is significantly reduced to a level comparable to the level of a plane plate. The dielectric provided with holes forms a frequency-selective volume with low-pass characteristics. The radar target cross-section produced by the corner reflectors within the cavity has been reduced to an acceptable level.

The dielectric, provided with holes, with an electrically conducting shells and also called artificial dielectric hereinafter exhibits a change both of the dielectric constant and the permeability constant. This entails that also the index of refraction is changed, or, more accurately, increases. The artificial dielectric also exhibits changed transmission and reflection characteristics. Low frequencies are transmitted and high frequencies are reflected. By varying the periodicity of the location of the shells in the dielectric and the size and shape of the shells, the artificial dielectric

can assume different frequency characteristics. For example, the artificial dielectric can be made to be mainly reflecting over a very large frequency range.

The dielectric used, provided with holes, entails that its size and the size of the antenna cavity can be reduced without reducing the antenna frequency bandwidth. This thus results in a more compact antenna with unchanged performance. The more compact format also makes possible a significant reduction in the weight of the antenna. A further weight reduction is produced by the dielectric according to the invention which, through its hole structure, has a lower weight per volume unit than the dielectric used earlier.

The hole spaces in the dielectric are advantageously periodically arranged in a threedimensional matrix, which results in a dielectric with adequate low-pass characteristics.

According to an advantageous embodiment of the antenna, the dielectric is divided up into a number of layers, each layer consisting of two part-layers with indentations arranged opposite one another in opposite surfaces of the part layers for forming hollow spaces. A dividing of the dielectric into layers and part layers according to this embodiment provides the antenna with great flexibility and makes the installation of the electrically conducting shells relatively uncomplicated. The shells are installed in the indentations of one part layer. After that the other cooperating part layer is installed. Each pair of part layers will contain a plane with conducting shells. The number of pairs of part layers comprised in the dielectric determines and corresponds to the number of planes with conducting shells.

In the text below, the invention will be described in greater detail with reference to the attached drawings, in which:

Figure 1 shows an embodiment of a cavity antenna according to the invention in a front view,

Figure 2 shows a section according to 2-2 in Figure 1 through the embodiment of the cavity antenna according to the invention,

Figure 3 shows for comparison a section corresponding to Figure 2 for a known cavity antenna, and

Figure 4 shows a layer of a dielectric included in the cavity antenna according to the invention in a perspective view and divided into two separate part layers.

The antenna 1 shown in Figure 1 and 2 comprises a cavity 2 mounted in a frame 3 in its open end. The aperture 4 of the antenna is defined by the open end of the cavity and is rectangular in the embodiment shown. A feed element 5 is arranged in the inside of the cavity 2 in its front part and has the shape of a T-shaped bar. A feed cable 6 connects the feed element 5 and the cavity 2 to external units and is preferably constituted by a coaxial cable.

The major part of the cavity 2 is filled with a di-

electric 7. In the embodiment shown, the dielectric 7 is divided into four layers 8, 9, 10, 11. However, the number of layers can vary from only one to significantly more than the four layers shown, depending on what is suitable for the actual antenna. The choice is determined by the size of the cavity 2 and the requirements for the characteristics of the dielectric 7.

Figure 4 shows layer 11 in a perspective view. Each layer 8, 9, 10, 11 is in turn divided into part layers, part layers 11a, 11b being shown for layer 11 in Figure 2 and 4. The part layers 11a, 11b have a plane surface 12a and 12b, respectively. In the plane surfaces, symmetrically arranged indentations 13a and 13b with an essentially hemispherical shape are located. When two part layers with opposite part layers 11a, 11b provided with indentations are assembled with the indentations opposite one another, a layer 11 with essentially spherical hollow spaces 14 is formed. Before two part layers 11a, 11b are assembled, one part layer 11a is provided with electrically conducting spherical shells 15 in the hemispherical indentations 13a. In an assembled layer 11, the shells 15 fill out the hollow spaces 14. The shells are made of metallic or metallized shells and can be made, for example, of silver-coated celluloid balls. The layers which enclose the electrically conducting shells are suitably made of material with low electromagnetic transmission losses for frequencies up to about 10 GHz and, for example, a material sold under the trademark Roasell, can be used.

By filling or covering the antenna cavity with artificial dielectric, the unwanted radiation is reduced which is otherwise reflected by the cavity in the direction of the incident radiation and is mainly caused by the corner reflectors in the interior of the cavity. The artificial dielectric is placed in front of the cavity bottom. The incident radiation is then reflected against the dielectric instead, since this is constructed for reflecting the frequencies or frequency ranges for which it is desired to reduce the radiation reflected by the cavity. If the normal to a three-dimensional matrix formed by the shells in the dielectric is not directed towards the incident radiation, the reflected radiation will be strongly reduced in the direction of incidence.

As comparison, it is shown in Figure 3 how a dielectric 7 is arranged in a known cavity antenna. Corresponding components in the known cavity antenna have been given the same reference designations as in Figures 1-2 and 4 for the cavity antenna according to the invention. As shown in Figure 3, the known antenna contains a homogeneous dielectric without division into layers and inhomogeneity-creating hollow spaces filled with electrically conducting shells. As indicated in the figure, the cavity 2 has a significantly greater depth than the antenna according to the invention shown in the same section in Figure 2.

By introducing an artificial dielectric according to the invention with hollow spaces, in which electrically

conducting shells are placed, a number of positive effects are created. The size of the cavity antenna can be reduced whilst retaining the frequency bandwidth, mainly due to the effect that the depth of the cavity can be reduced.

The antenna can be made lighter due to its reduced size and due to the fact that the artificial dielectric has a lower weight than the homogeneous dielectric previously used. The artificial dielectric also reduces the monostatic radar target cross-section of the antenna.

To reduce the radar target cross-section of the cavity antenna further, the antenna aperture can be covered with a plane frequency-selective structure constructed of one or several parallel layers provided with metallic periodic patterns. Such a structure, also called radome, has been shown as a plane layer 16 covering the aperture 4 of the cavity antenna in Figure 2. The radome 16 is ideally transparent to the operating frequency band of the antenna and reflecting for all other frequencies.

By filling the antenna cavity with the artificial dielectric described above and covering the antenna aperture with a frequency-selective radome, the radar target cross-section of the antenna has changed appearance from being considered as a four corner reflector to being considered as a plane plate.

Claims

1. Antenna for transmitting and/or receiving electromagnetic radiation comprising a cavity, an aperture arranged in front of the cavity, a feed element arranged in the cavity, and a dielectric arranged in connection with the cavity, characterised in that the dielectric is provided with hollow spaces and that these hollow spaces contain electrically conducting shells.
2. Antenna according to Claim 1, characterised in that the hollow spaces are periodically arranged in a three-dimensional matrix.
3. Antenna according to any of the preceding claims, characterised in that the dielectric is divided into a number of layers.
4. Antenna according to Claim 3, characterised in that each layer consists of two part layers with indentations arranged opposite one another in opposite surfaces of the part layers for forming hollow spaces.
5. Antenna according to Claim 4, characterised in that the indentations have an essentially hemispherical shape.

6. Antenna according to any of the preceding claims, characterised in that a radome plate is arranged in front of the aperture of the antenna.

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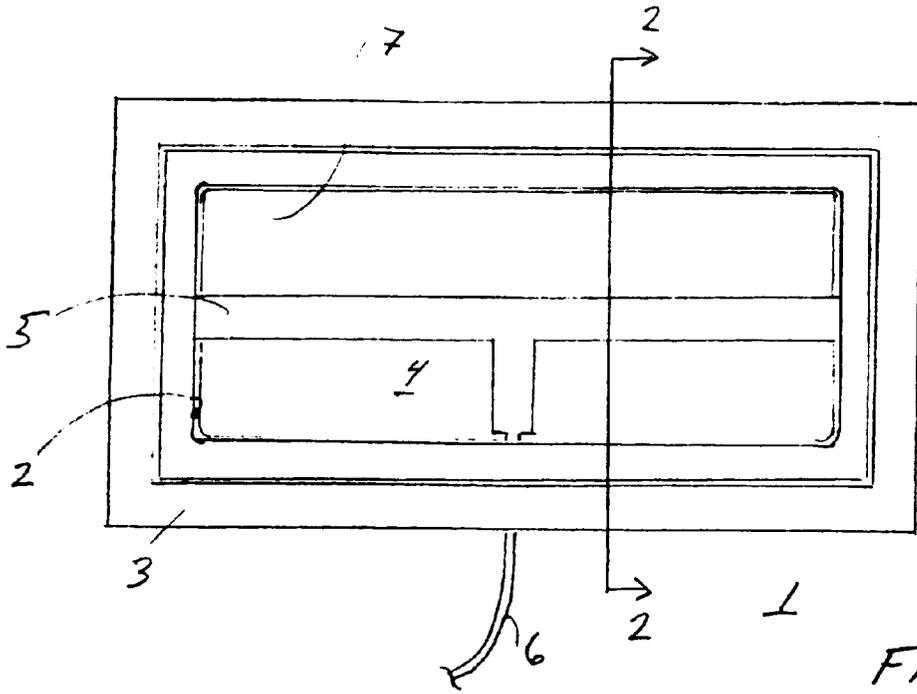


Fig 1

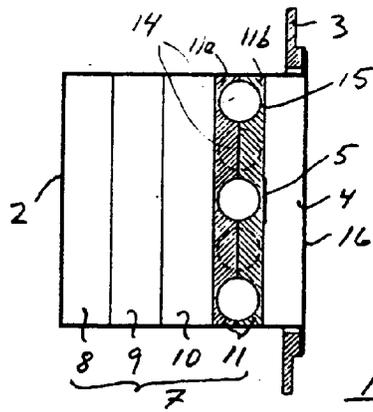


Fig 2

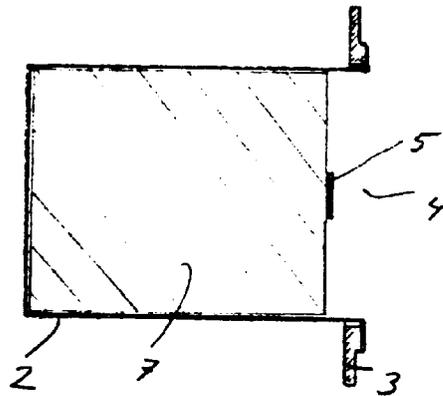
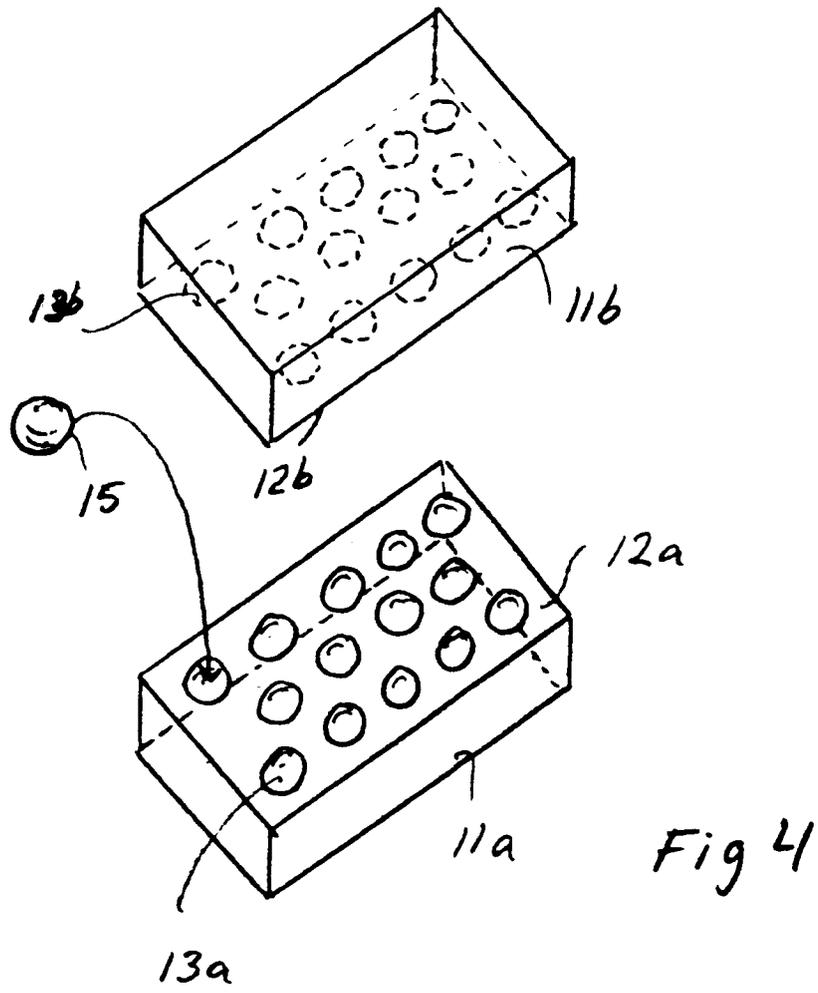


Fig 3





European Patent
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EUROPEAN SEARCH REPORT

Application Number

EP92850148.5

| 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 | US-A- 2 579 324 (W.E. KOCK) *Column 15, line 4 - column 18, line 19; figures 10-15* | 1-3 | H 01 Q 13/02 H 01 Q 15/10 |
| Y | --- | 4-6 | |
| Y | PATENT ABSTRACTS OF JAPAN, Vol 9, No 193 (E-334) abstract of JP 60-062202, publ. 10 April 1985, MURATA SEISAKUSHO K.K. | 4, 5 | |
| Y | US-A- 2 658 145 (A. DORNE ET AL) *column 6, line 24 - line 28* | 6 | |
| | | | TECHNICAL FIELDS SEARCHED (Int. Cl.5) |
| | | | H 01 Q |
| The present search report has been drawn up for all claims | | | |
| Place of search | | Date of completion of the search | Examiner |
| STOCKHOLM | | 1992-11-04 | MAGNUSSON. G. |
| <p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>I : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons</p> <p>& : member of the same patent family, corresponding document</p> | | | |

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