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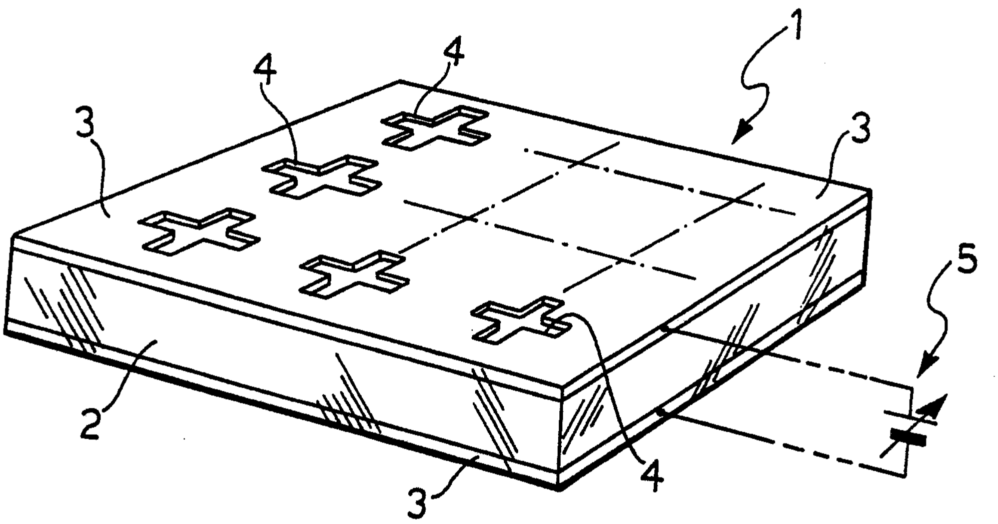
(54) Title: A FREQUENCY-DISCRIMINATING DICHROIC STRUCTURE WITH A VARIABLE PASSBAND AND APPLICATIONS THEREOF



(57) Abstract

The structure includes at least one substrate (2) of dielectric material, at least one face of which carries an orderly and geometrically periodic array of elements of electrically conductive material or, in a converse manner, bears at least one layer (3) of conductive material having an orderly and geometrically periodic array of holes (4). The structure is characterised in that control means (5, 6; 7) are associated with the substrate (2) of dielectric material for varying the dielectric or magnetic constant of the material so as correspondingly to modify its passband.

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A frequency-discriminating dichroic structure with a variable passband and applications thereof

The present invention relates to a dichroic structure for the selective attenuation according to frequency of incident electromagnetic waves the frequencies of which fall outside a predetermined passband.

More specifically, the invention concerns a dichroic structure including at least one substrate of dielectric material, at least one face of which bears an orderly and geometrically periodic array of elements of an electrically conductive material or a layer of conductive material having an orderly and geometrically periodic array of holes.

For example, such a dichroic structure considerably increases the communication capacity of a system having an antenna with reflectors, enabling it to operate at several frequencies. This drastically reduces the weight, bulk and cost of an antenna system, which advantages are of great importance for application to satellite communications systems.

In the avionics field, however, frequency-discriminating dichroic structures may be used for forming radomes with well-defined transmission bands.

The object of the present invention is to provide a dichroic structure with a variable working (transmission or reflection) band.

According to the invention, this object is achieved by a dichroic structure of the type specified above, characterised in that control means are associated with the substrate of dielectric material for varying the dielectric or magnetic constant of the material so as correspondingly to modify its working band.

In a first embodiment, the dielectric material used has a dielectric or magnetic constant which is variable as a result of the application of a potential difference across the material and the control means are arranged to apply a quasi-static, variable potential difference across the dielectric substrate.

In a further embodiment, the dielectric material used has a dielectric or magnetic constant which can be varied significantly in dependence on its temperature and the control means comprise heating means for changing the temperature of the dielectric material. The heating means may comprise means for generating a high-frequency magnetic field to heat the dielectric material by induction or may be resistive heating means for changing the temperature of the dielectric material by the Joule effect.

In a further embodiment, the dielectric material used has a dielectric or magnetic constant which can be varied as a result of the application of mechanical stress to the material, and the control means are arranged accordingly to apply such mechanical stress to the dielectric substrate material.

Further characteristics and advantages of the invention will become clear from the detailed description which follows with reference to the appended drawings, provided purely by way of non-limiting example, in which:

Figure 1 is a perspective view of a quadrangular portion of a dichroic structure according to a first embodiment of the invention,

Figure 2 is a perspective view of a quadrangular portion of another dichroic structure according to the invention,

Figure 3 is a perspective view of a quadrangular portion of a dielectric material used in a dichroic structure according to the invention, the portion having induction heating means, and

Figure 4 is a graph showing schematically the attentuation characteristic of a dichroic structure according to the invention as a function of the frequency shown on the abscissa.

In Figure 1, a portion of a dichroic structure, indicated 1, comprises a substrate 2 of dielectric material with two layers 3 of electrically conductive material, typically metal, on its faces. The layers 3 may be formed in any known manner and each has a respective orderly and geometrically periodic array of holes 4 which, in the embodiment shown by way of example, are cross-shaped.

The substrate 2 is made of a dielectric material with a dielectric constant ϵ or a magnetic constant μ which can be varied as a result of the application of a potential difference across the material. An example of such a material is barium titanate.

The terminals of a variable voltage supply, indicated 5 in Figure 1, are connected to the two conductive layers of the dichroic structure.

Variations of the voltage supplied by the supply 5 thus vary the dielectric constant or the magnetic constant of the material constituting the substrate 2, correspondingly shifting the passband of the dichroic structure 1 as shown, for example, in Figure 4. This drawing shows, by way of example, the curve of the attenuation A of the electromagnetic waves incident normally on the dichroic structure, as a function of the frequency f.

When the potential difference or voltage supplied by the supply 5 assumes a first value, the dichroic structure shown in the drawing will have an attenuation characteristic, for example, of the type indicated A_1 in Figure 4 with a central working frequency f_1 and a bandwidth B_1 around that frequency.

When the potential difference or voltage supplied by the supply 5 assumes a second value different from the first, the dichroic structure will have an attenuation characteristic with a shifted frequency, such as the characteristic indicated A_2 in Figure 4, which has a passband B_2 centered on a working frequency f_2.

Figure 1 described above relates to an embodiment of the invention in which the passband of the dichroic structure is shifted by the application of a quasi-static voltage, that is, a voltage whose variation with time takes place at a frequency much lower than the working frequency of the dichroic structure.

In Figure 2, which shows a variant, the same reference numerals have again been assigned to parts and elements already described.

The dichroic structure of Figure 2 includes a substrate 2 of dielectric material whose dielectric or magnetic constant can be varied sensitively as a result of changes in the temperature of the material. A conductive layer 3 applied to at least one face of the dielectric substrate 2 has an orderly and geometrically periodic array of holes 4. Alternatively, at least one face of the dielectric substrate 2 could have a converse conductive structure, that is, an orderly and geometrically periodic array of elements of an electrically conductive material whose shapes are complementary to those of the holes 4 in the layer 3 shown in Figure 2.

A resistive element 6 which, in the embodiment illustrated, has a serpentine shape is applied to the face of the substrate 2 opposite that carrying the conductive material 3. The terminals of the resistive element 6 are connected to a variable supply 5. Variations in the current flowing in the resistive element 6 vary the heat dissipated by the Joule effect, correspondingly varying the temperature of the material constituting the substrate 2. The variation thus induced in the dielectric constant and/or the magnetic constant of the material causes a shift in the passband of the dichroic structure 1.

Naturally, devices or systems other than that shown by way of example may be used to heat the substrate 2 of dielectric material by the Joule effect.

Figure 3 shows a portion of a substrate 2 of dielectric material whose dielectric and/or magnetic constant can vary appreciably as a result of a change in the temperature of the material. In the embodiment of Figure 3, a conductive element 7 is wrapped around the substrate 2 as a helix, its terminals conveniently being connected to a high-frequency generator (not shown). The helix constituted by the element 7 heats the dielectric sheet 2 by induction.

With the use of a substrate of the type shown in Figure 3 in a dichroic structure, the frequency passband of the structure can be shifted at will or when necessary.

Other embodiments are possible in addition to those shown by way of example in Figures 1 to 3.

Thus, for example, a material whose dielectric constant can be varied as a result of the application of mechanical stress may be used as a single or layered dielectric substrate.

Examples of such materials are crystalline and siliceous materials. In this case, the passband of the dichroic structure can also easily be shifted by the application of mechanical stress thereto.

The dichroic structures with variable passbands according to the invention may conveniently be used in the antennae of telecommunications satellites or for the construction of "stealth" radomes, that is, those which cannot be detected by microwave radar.

Naturally, the principle of the invention remaining the same, the forms of embodiment and details of construction may be varied widely with respect to those described and illustrated purely by way of non-limiting example, without thereby departing from the scope of the present invention.

CLAIMS

1. A dichroic structure for the selective attenuation of incident electromagnetic waves the frequencies of which fall outside a predetermined passband (B), including at least one substrate (2) of dielectric material, at least one face of which carries an orderly and geometrically periodic array of elements of electrically conductive material or, in a converse manner, bears at least one layer of conductive material (3) having an orderly and geometrically periodic array of holes (4),

the structure being characterised in that control means (5, 6; 7) are associated with the substrate (2) of dielectric material for varying the dielectric or magnetic constant of the material so as correspondingly to modify its passband (B).

2. A dichroic structure according to Claim 1, characterised in that the dielectric material has a dielectric and/or magnetic constant which is variable as a result of the application of a potential difference across the material, and in that the control means (5, Figure 1) are arranged to apply a variable potential difference across the dielectric substrate (2).

3. A dichroic structure according to Claim 2, including at least one substrate (2) of a dielectric material carrying on each face a layer of electrically conductive material (3) with an orderly and periodic array of holes (4), characterised in that the control means comprise means (5) for applying a potential difference across the conductive layers (3) on the at

least one substrate (2) of dielectric material.

4. A dichroic structure according to Claim 1, characterised in that the control means comprise heating means (5, 6; 7) for varying the temperature of the dielectric material (2).

5. A dichroic structure according to Claim 4, characterised in that the heating means comprise means (7) for generating a high-frequency magnetic field to heat the dielectric material (2) by induction.

6. A dichroic structure according to Claim 4, characterised in that Joule-effect heating means (5, 6) are associated with the dielectric material (2).

7. A dichroic structure according to Claim 1, characterised in that the control means are arranged to vary the dielectric and/or magnetic constant of the dielectric material (2) by the application of mechanical stress to the substrate sheet (2).

8. The use of a dichroic structure according to one or more of the preceding claims for forming a radome which is not detectable by microwave radar.

9. The use of a dichroic structure according to one or more of Claims 1 to 7 for forming an antenna for use on a telecommunications satellite.

FIG. 1

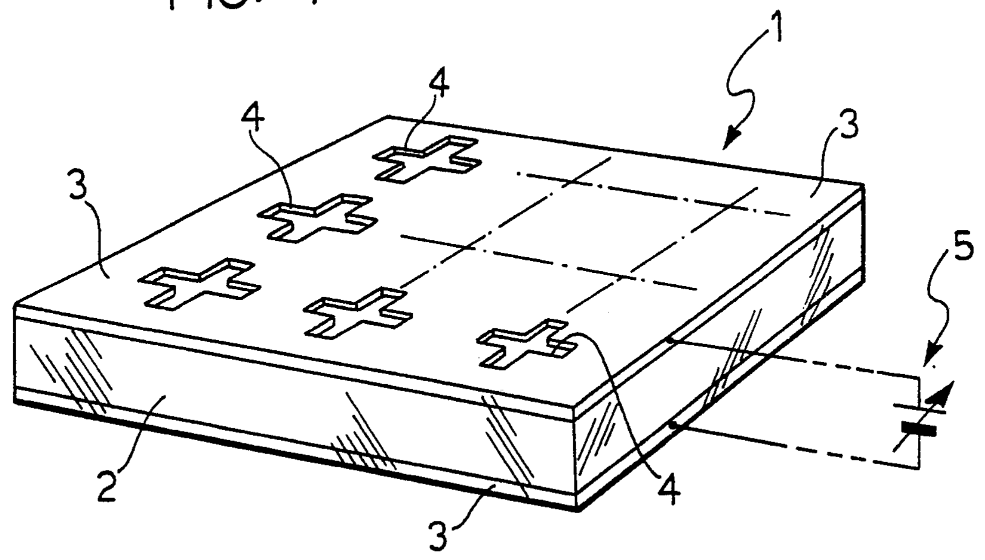


FIG. 2

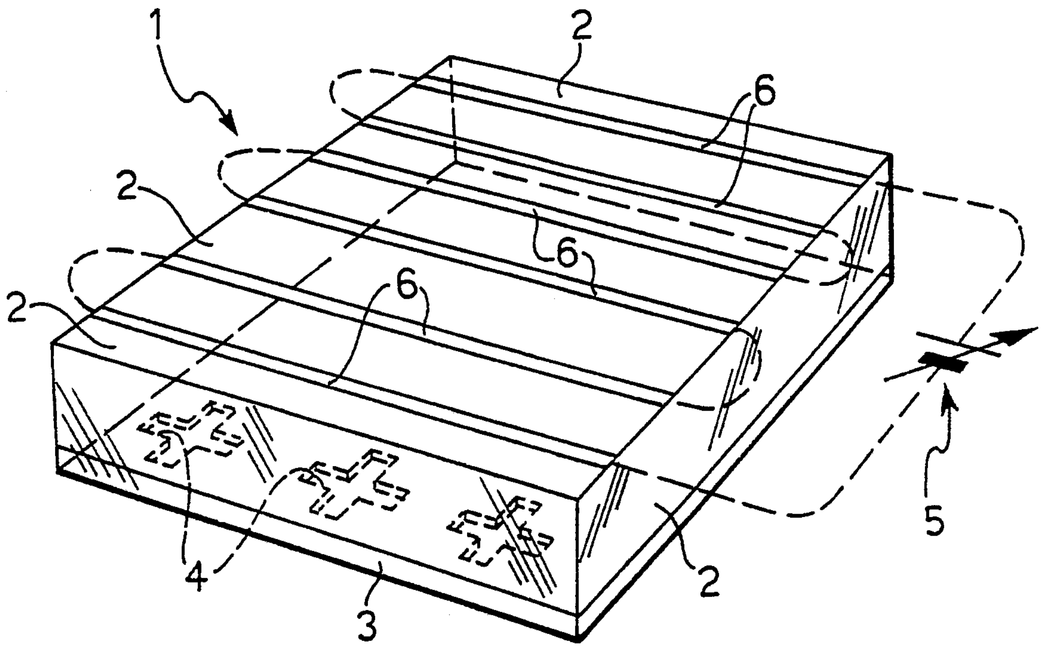


FIG. 3

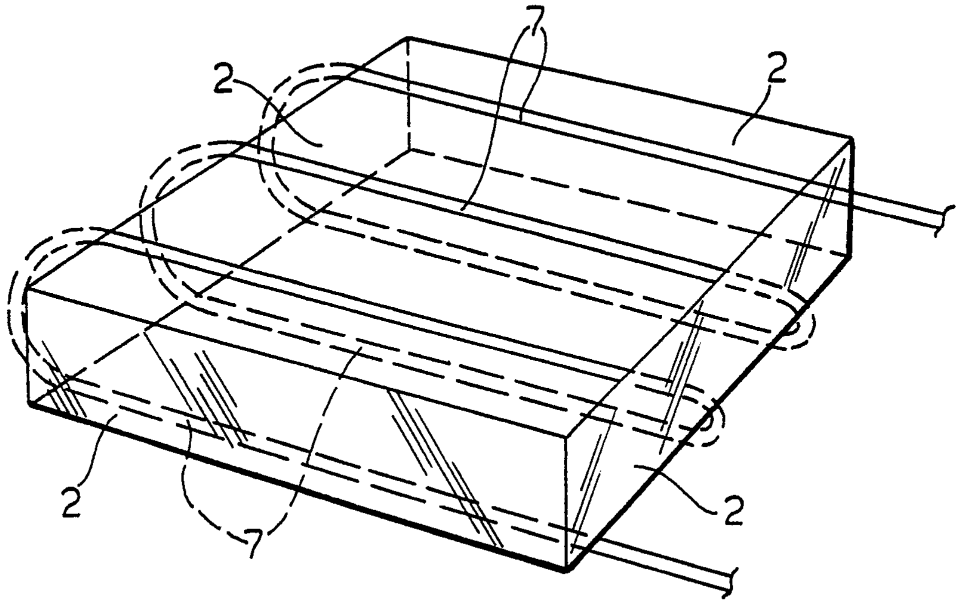
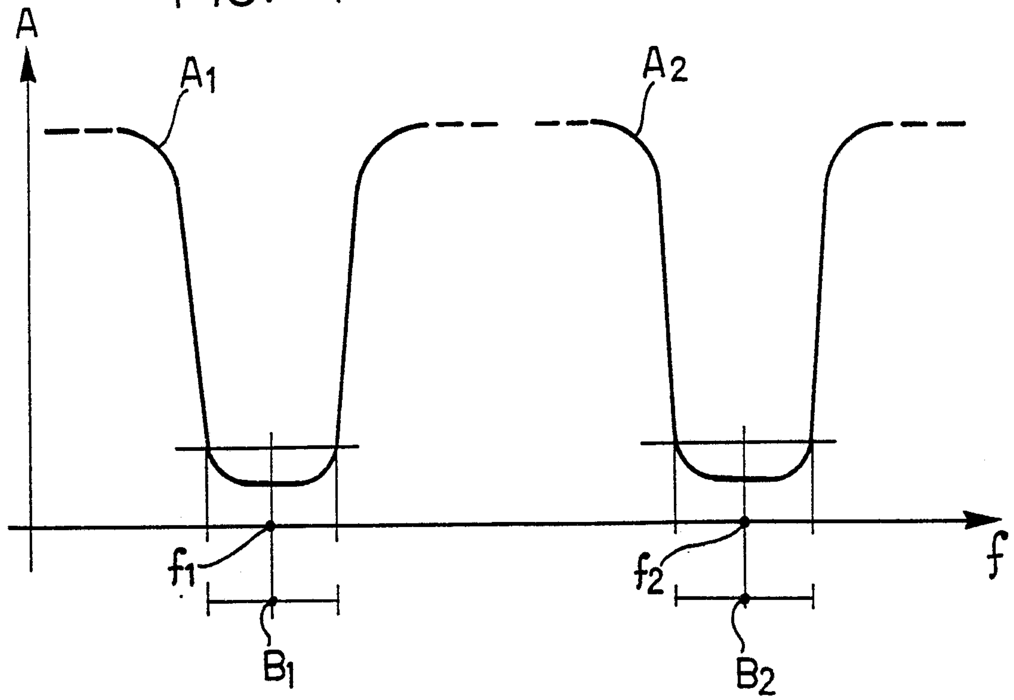


FIG. 4



INTERNATIONAL SEARCH REPORT

International Application No PCT/EP 92/00386

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 H01Q15/00; H01Q3/44

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	H01Q

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
Y	WO,A,9 014 696 (JOHANSSON) 29 November 1990 see claims 1-5; figures 3A-3B ---	1-9
Y	US,A,3 309 704 (KLINGLER) 14 March 1967 see claims 1-17; figures 5-9 ---	1-9
A	US,A,4 987 418 (KOSOWSKY) 22 January 1991 see claims 1-5; figures 1-4 ---	1-3
A	US,A,3 631 501 (BUSCHER) 28 December 1971 see claims 1-3; figures 1,11-13 ---	1-3,8,9

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
11 MAY 1992	29. 05. 92
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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO-A-9014696	29-11-90	SE-B- 463692 AU-A- 5722590 EP-A- 0472636 SE-A- 8901789	07-01-91 18-12-90 04-03-92 20-11-90
US-A-3309704		None	
US-A-4987418	22-01-91	None	
US-A-3631501	28-12-71	None	

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