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(54) Resonant cavity filter for microwave signals

(57) In a filter for microwave signals comprising a plurality of resonant cavities and a longitudinal passage connecting them to each other, said plurality of resonant cavities and said longitudinal passage are entirely filled with a dielectric material whose relative permittivity ε_r is greater than one.

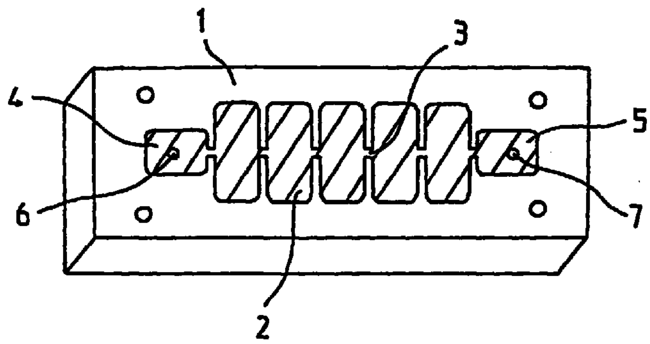

FIG.1

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a resonant cavity filter for microwave signals.

[0002] Typically, a filter for microwave signals consists of a panel comprising a succession of resonant cavities communicating with each other through a longitudinal passage. The size and central frequency of the passband of the filter depend on the size and number of these resonant cavities.

[0003] The usual criteria for the choice of a filter are the following:

- low loss in transmission and high attenuation of matching in the passband,
- a high rejection in near band,
- good behavior in temperature throughout the band,
- simple manufacture to obtain low cost price.

[0004] Furthermore, owing to the widespread miniaturization of electronic equipment, it is now becoming essential to have small-sized filters.

[0005] The invention therefore is the result of research carried out on filters for microwave signals with a view to reducing their size and making them more compact.

SUMMARY OF THE INVENTION

[0006] To this end, an object of the invention is a filter for microwave signals comprising a plurality of resonant cavities and a longitudinal passage, connecting them to each other, wherein said plurality of resonant cavities and said longitudinal passage are entirely filled with a dielectric material whose relative permittivity ε_r is greater than one.

[0007] Thus, the waves get propagated inside the filter in a dielectric material with a permittivity greater than that of air (ε_r=1), making it possible to reduce the volume of the resonant cavities of the filter and therefore increase the compactness of the filter. Indeed, the Maxwell equations show that the electromagnetic behavior of an air-filled metal body is identical to that of this same body filled with a dielectric material having a relative permittivity ε_r provided that the size of this material is reduced by a ratio $\sqrt{\varepsilon_r}$ on each of its dimensions.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The characteristics and advantages of the invention mentioned here above as well as others shall appear more clearly in the following description made with reference to the single figure, Figure 1, which gives a view in perspective of a passband filter according to the invention.

[0009] For reasons of convenience, the following description shall refer to a passband filter without any limit being placed on the type of filters concerned by the invention.

[0010] The solution proposed by the invention for reducing the size of the filters for microwave signals consists in filling the resonant cavities of the filter and the longitudinal passage connecting them with a dielectric material having a relative permittivity ε_r greater than that of air. Thus, the medium of propagation of a standard filter, namely air, is replaced with a dielectric material having a permittivity greater than one.

[0011] A structure of this kind enables a gain in volume corresponding to the value of $\varepsilon_r^{3/2}$ as compared with that of a standard filter. For example, if we use a dielectric material with a permittivity of 4, the gain in volume is 8.

[0012] An exemplary passband filter 1 according to the invention is shown in the single figure. This filter has four successive resonant cavities 2 connected to each other by a longitudinal passage 3, an input port 4 and an output port 5 at the two ends of the succession of cavities, all these elements being hollowed out of a perfectly conductive metal block. Naturally, the block shown is surmounted by a metal hood (not shown).

[0013] According to the invention, the resonant cavities 2, the longitudinal passage 3 as well as the port 4 and the port 5 of the filter are entirely filled with a dielectric material having a relative permittivity ε_r greater than one. The dielectric material is a ceramic material, for example a styrene copolymer.

[0014] This filter structure then has a small space requirement which is a consequence of two observations:

- a filter structure having a given response at the frequency f_0 will have the same response as the frequency

$$\frac{f_0}{\sqrt{\varepsilon_r}}$$

  when it is filled with a dielectric having a permittivity ε_r; and
- the central frequency f_0 of a filter is transposed to the frequency $k.f_0$ when its dimensions are uniformly reduced by a factor k (k≥1).

[0015] Thus, the reduction of the dimensions of the filter by a factor k is compensated for by the fact that it is filled with a dielectric having a relative permittivity $\varepsilon_r = k^2$.

[0016] Preferably, the dielectric used is homogeneous, namely it has microscopic characteristics that are uniform in space, and it is isotropic, namely its characteristics are identical in all directions so as not to introduce excessive electromagnetic losses.

[0017] Indeed, it may be recalled that the dielectric character of a material is displayed by the appearance of polarizing dipoles at each molecule that constitutes it when it is exposed to an electrical field. This phenomenon is modelled by a distribution of fictitious loads distributed in the volume and on the surface of the material. For a homogeneous, linear and isotropic dielectric, the bias is written as follows: $\vec{p} = \varepsilon_0 . \chi . \vec{E}$ where χ is a scalar constant that is proper to the material and is called electrical susceptibility. Within a dielectric of this kind, the electric magnetic fields are defined by the Maxwell equations in taking $\varepsilon_r = \varepsilon_0 .(1+\chi)$. Conduction and absorption phenomena within the dielectric lead to losses of electromagnetic energy. This is taken into account by the introduction of an imaginary part of the electrical susceptibility. The permittivity then becomes complex and is written as $\varepsilon_r = \varepsilon' + j\varepsilon''$. The energy losses within the dielectric are expressed by the factor $\varepsilon''/\varepsilon'$. The lower this factor, the lower are the losses.

[0018] Consequently, the dielectric material chosen advantageously has a very low factor $\varepsilon''/\varepsilon'$, for example below 0.002. However, the fact remains that a material of this kind always has losses; it cannot therefore be used for applications requiring very low insertion losses.

[0019] Apart from the insertion losses, a filter of this kind however has high electrical characteristics. It even has a near-band rejection that is greater than that of a classic filter.

[0020] Furthermore, the other criteria for choosing the dielectric material are the following: it must be easy to machine or mold, insensitive to ageing and have an coefficient of expansion close to that of the metal in which the cavities are made.

[0021] In the exemplary embodiment of Figure 1, it is furthermore planned, for the junction of a coaxial cable at the input and output of the filter, to have holes 6 and 7 in the dielectric at the level of the input port 4 and output port 5 of the filter. These holes 6 and 7 are designed respectively to receive the core of the coaxial cable at input and the core of the coaxial cable at output.

[0022] For a junction with a standard rectangular waveguide having a different impedance value and a different section, it is planned to introduce a quarter-wave line between the guide and the corresponding port of the filter for the impedance matching and a convergent guide to provide for the change in sections.

Claims

1. A filter for microwave signals comprising a plurality of resonant cavities and a longitudinal passage connecting them to each other, wherein said plurality of resonant cavities and said longitudinal passage are entirely filled with a dielectric material whose relative permittivity ε_r is greater than one.

2. A filter according to claim 1, wherein the dielectric material is a homogeneous and isotropic ceramic material.

3. A filter according to claim 2, wherein the dielectric material is a styrene copolymer.

4. A filter according to one of the claims 1 to 3, wherein the chosen dielectric material has a relative permittivity $\varepsilon_r = \varepsilon' + j\varepsilon''$ for which the ratio $\varepsilon''/\varepsilon'$ is low.

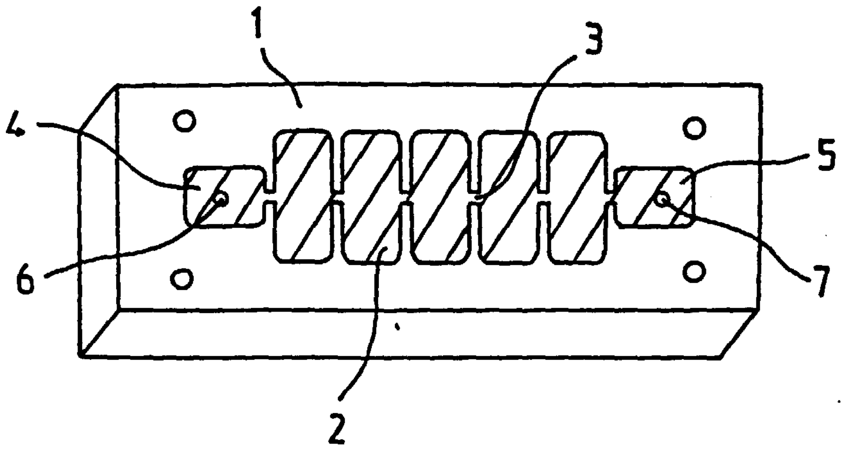

FIG.1

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EUROPEAN SEARCH REPORT

Application Number
EP 00 30 1206

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	ABDELMONEM A ET AL: "SPURIOUS FREE D.R. TE MODE BAND PASS FILTER" IEEE MTT-S INTERNATIONAL MICROWAVE SYMPOSIUM DIGEST, SAN DIEGO, MAY 23 - 27, 1994, vol. 2, 23 May 1994 (1994-05-23), pages 735-738, XP000516655 KUNO H J;WEN C P (EDITORS) ISBN: 0-7803-1779-3 * page 735, right-hand column, line 9 - line 17 * * page 737, right-hand column, line 4 - line 8; figure 1B *	1	H01P1/208
Y		2-4	

Y	MODELSKI J ET AL: "INTEGRATED INPUT CIRCUIT FOR SATELLITE CONVERTER" PROCEEDINGS OF THE EUROPEAN MICROWAVE CONFERENCE, LONDON, SEPT. 4 - 7, 1989, no. CONF. 19, 4 September 1989 (1989-09-04), pages 543-548, XP000067322 MICROWAVE EXHIBITIONS AND PUBLICATIONS LTD * page 544, line 14 - line 26; figures 2A,B *	2-4	TECHNICAL FIELDS SEARCHED (Int.Cl.7): H01P

X	US 4 837 535 A (KONISHI ET AL.) 6 June 1989 (1989-06-06) * column 3, line 61 - column 4, line 3; figure 4A *	1	

A	PATENT ABSTRACTS OF JAPAN vol. 15, no. 494 (E-1145), 13 December 1991 (1991-12-13) & JP 03 216001 A (FUJI ELECTROCHEM CO LTD), 24 September 1991 (1991-09-24) * abstract *	1,2	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	25 May 2000	Den Otter, A

CATEGORY OF CITED DOCUMENTS

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

T : 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

& : member of the same patent family, corresponding document

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 00 30 1206

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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25-05-2000

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4837535 A	06-06-1989	NONE	
JP 03216001 A	24-09-1991	JP 2110803 C	21-11-1996
		JP 7093524 B	09-10-1995

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82