

(19)



Europäisches Patentamt

European Patent Office

Office européen des brevets



(11)

**EP 0 871 235 A2**

(12)

**EUROPEAN PATENT APPLICATION**

(43) Date of publication:

**14.10.1998 Bulletin 1998/42**(51) Int Cl.<sup>6</sup>: **H01P 1/208**(21) Application number: **98400865.6**(22) Date of filing: **09.04.1998**

(84) Designated Contracting States:

**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU  
MC NL PT SE**

Designated Extension States:

**AL LT LV MK RO SI**(30) Priority: **11.04.1997 ES 9700777**(71) Applicant: **ALCATEL ALSTHOM COMPAGNIE****GENERALE D'ELECTRICITE****75008 Paris (FR)**

(72) Inventors:

- **Caceres Armendariz, José Luis**  
**28760 Tres Cantos (Madrid) (ES)**
- **Shamsaifar, Khosro**  
**28043 Madrid (ES)**
- **Delgado Cabello, Silvia**  
**28009 Madrid (ES)**

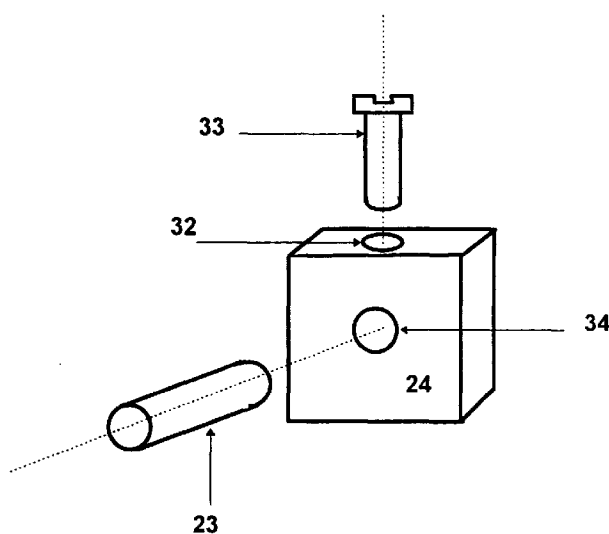
(74) Representative: **Feray, Valérie et al**

**Compagnie Financière Alcatel,**  
**DPI,**  
**30, avenue Kléber**  
**75116 Paris (FR)**

**(54) Microwave filter with coupling elements**

(57) A microwave filter with multiple resonant cavities that are delimited by conducting walls and arranged consecutively. Two adjacent walls are coupled by means of a coupling element comprising a first opening in the common wall of said cavities, a probe (23) positioned in said first opening, which produces a coupling of opposite sign to that defined by said first opening and,

also, includes movable adjustment means (33) which penetrate the first opening and whose function is to adjust the overall value of the coupling produced by the combination of said first opening and said probe (23). Consequently, a progressive adjustment of the overall value of the coupling is obtained in a wide range of values.

**FIG. 3****EP 0 871 235 A2**

## Description

### OBJECT OF THE INVENTION

The present invention refers to a microwave filter and, in particular, to a microwave filter with multiple resonant cavities for use in communication systems, as applied especially, but not exclusively, to satellite communications.

### STATE OF THE ART

Microwave filters with multiple resonant cavities which include specific coupling elements are known, for instance, through the patent application WO 95/27317, "DIELECTRIC RESONATOR FILTER" which, being referred to in the present patent application, is included in it.

In said patent application WO 95/27317, a mono-mode microwave filter with multiple resonant cavities which includes two rows of resonant cavities is described, the electromagnetic energy between successive or adjacent cavity resonators being coupled by means of slots in the walls that separate said cavities, or by means of probes located in said walls; the purpose of said couplings is to obtain a filter-type response of determined characteristics.

The probe is usually situated in an opening made in a wall that separates two cavities by means of an insulating material which serves as a mechanical support and at the same time prevents electrical contact between the wall and the probe. When the probe is positioned in the wall between two adjacent but non-consecutive cavities, the coupling produced is called "cross-coupling".

If, for instance, the coupling produced by the slot is mathematically defined as positive, usually the coupling is made through the probe of the opposite sign. The sign and the coupling value that correspond to the probe depend on its length, geometry and relative position with respect to the electromagnetic fields within the resonant cavities.

The combination of positive and negative couplings together with the existence of cross couplings produces zeros in transmission or equalization zeros. Consequently, in the microwave filter with resonant cavities, the presence of said zeros enables a complex transfer function to be obtained. Depending on the desired transfer function, a determined configuration of positive and negative couplings will be applied.

The adjustment of the coupling value produced by a probe is complicated since the effect produced by said probe cannot easily be formulated as a mathematical model. Therefore, the filter adjustment process requires several probes to be tested in order to obtain the desired output characteristics. Consequently, the microwave filter adjustment process requires a long time and this process is expensive.

## CHARACTERIZATION OF THE INVENTION

One object of the invention is to provide a microwave filter with multiple resonant cavities which features couplings between adjacent cavities, so that the process for obtaining the output characteristics of said filter is simple, fast and easily repeatable. Consequently, the cost of the process for adjusting the microwave filter is reduced.

The microwave filter with multiple resonant cavities of the invention is made up of resonant cavities delimited by conducting walls, said resonant cavities being arranged in such a way that they are ordered consecutively.

In said filter, at least two adjacent cavities are coupled by means of a coupling element comprising at least one first opening in a common wall to said two adjacent cavities, producing a coupling that is mathematically defined as positive; a probe that is placed in said first opening which produces a coupling of opposite sign to that defined by said first opening and, also, includes movable adjustment means which penetrate in the first opening and whose function is to adjust the overall value of the coupling produced by the combination of said first opening and said probe.

Accordingly, a progressive adjustment of the overall value of the coupling is obtained in a wide range of values, and the process of adjusting the output signal of the microwave filter with the coupling element of the invention is fast, simple and easy to carry out, and also of low cost.

### BRIEF DESCRIPTION OF THE DRAWINGS

A more detailed explanation of the invention is given in the following specification based on the attached drawings, in which:

- figure 1 shows a plan-view of a microwave filter body with multiple resonant cavities, according to the invention,
- figure 2 shows a perspective view of a conducting wall which is common to two attached and non-consecutive cavities, according to the invention, and
- figure 3 shows a perspective view of a coupling element, according to the invention.

### DESCRIPTION OF THE INVENTION

Figure 1 shows a plan view of the body 11 of a microwave filter with multiple resonant cavities according to the invention, in which the cover of said filter has been removed, so that six consecutively arranged cavities 14,15,16,17,18,19, which are delimited by conducting walls, may be distinguished.

Here, the microwave filter with six cavities 14 to 19

will be used, the cavities being arranged for instance, in two rows as an example for describing a preferred embodiment of the invention, without this restricting the use of same to said filter with six resonant cavities.

The signal which is filtered by the microwave filter is applied to an input terminal 12 and the filtered signal is available at an output terminal 13 of said filter.

The cavities 14 to 19 arranged in two rows, have common conducting walls so that in a conducting wall that is common to the two adjacent and consecutive cavities 14, 15 there is one slot 21 respectively, said slot 21 producing a coupling between the same, and said coupling being mathematically defined as positive.

On the other hand, a cross-coupling is one that is produced between two cavities, for example 15 and 18, which are attached but non-consecutive. Accordingly, the combination of positive and negative couplings together with the existence of cross-coupling produces zeros in transmission or equalization zeros, and thus the microwave filter with resonant cavities features a complex transfer function.

The cross-coupling between at least two adjacent non-consecutive cavities, for example 15, 18, is produced by means of a coupling element which comprises at least one first opening 22 which produces a coupling that is, for instance, mathematically defined as positive. Said first opening 22 is carried out in a conducting wall 20 that is common to said cavities 15, 18.

In the preferred embodiment of the invention, said first opening 21 is centered in the conducting wall 20; however, in other embodiments it may be moved in relation to the centre of said conducting wall 20.

Also, it comprises at least one probe 23 which is positioned by means of an insulating material 24 in the first opening 22; said insulating material 24 serves as a mechanical support and at the same time prevents electrical contact between the conducting wall 20 and said probe 23.

The probe 23 produces a coupling of opposite sign to that produced by the first opening 22. Moreover, it includes movable adjustment means 33, for example a screw, which penetrates said opening 22, so that by moving them the overall value of the coupling is adjusted (see figures 2 and 3). Said movable adjustment means 33 are accessible from outside the microwave filter body 11. Moreover, when moved in order to adjust the output characteristics of the filter, said movable adjustment means 33 can penetrate into the insulation material 24 through a hole 34.

The probe 23 is usually made of conductive materials and the coupling value produced by the same is a function of its geometry (symmetrical or asymmetrical) and of its physical dimensions (length).

The process for obtaining the output characteristics of the microwave filter will be carried out by moving the adjustable coupling means 33, which is a simple and easily repeatable operation as said means are accessible from outside the filter. Consequently, during the

process of adjusting the filter, it will not be necessary to change the probe 23 which is defined theoretically in the design process of said microwave filter.

The insulating material 24 which serves as a mechanical support for the probe 23 has a perforation 34 which passes completely through it and in which said probe 23 is housed, protruding on both sides of said insulating material 23 (see figure 3).

According to how the coupling element is designed, that is, the first opening 22 and the probe 23, the movable adjustment means 33 will change not only the overall value of the coupling, but also the sign of the same. For this purpose, the couplings respectively produced by the first opening 22 and the probe 23 must be nearly equal.

In an alternative embodiment, the cross-coupling may be obtained as a combination of two openings, containing for instance, the first opening 22, the probe 23 with the adjustable coupling means 33 being placed in the second opening, or in the two openings, respectively. Therefore, said two openings will usually be moved in relation to the centre of the conducting wall 20 that is common to the two adjacent cavities 15, 18.

In another embodiment, the coupling element will be situated, for instance, in the conducting wall that is common to the two adjacent and consecutive cavities 14, 15, producing a negative coupling, said conducting wall not presenting the slot 21. The first opening 22 of the coupling element will usually be moved in relation to the centre of the conducting wall that is common to the two adjacent and consecutive cavities 14, 15.

According to the invention, the described coupling element has means for adjusting the overall value and the coupling sign it produces; positive and negative couplings may thus be obtained with said coupling element.

## Claims

1. **MICROWAVE FILTER** with multiple resonant cavities, said cavities being delimited by conducting walls and at least two adjacent cavities (15, 18) being coupled by a coupling element, **characterized** in that said coupling element comprises:

- at least one first opening (22) in a conducting wall (20) that is common to said adjacent and non-consecutive cavities (15, 18) which produces a coupling,
- at least one probe (23) positioned in said first opening (22), producing a coupling of opposite sign to that produced by said first opening (22),
- at least one movable adjustment means (33) which penetrates into said first opening (22) in such a way that it adjusts the overall value of the coupling produced by said first opening (22) and said probe (23).

2. **MICROWAVE FILTER** according to claim 1, **characterized** in that said coupling element is located in a conducting wall that is common to two adjacent and consecutive cavities (15, 16).

5

3. **MICROWAVE FILTER** according to claim 1, **characterized** in that the first opening (22) and the probe (23) have such dimensions that their couplings compensate respectively in such a way that by varying the position of the movable adjustment means (33), as many coupling values with positive sign as with negative sign are obtained.

10

4. **MICROWAVE FILTER** according to claim 1, **characterized** in that the coupling element also includes a second opening in which the movable adjustment means (33) penetrate, and the probe (23) is situated in the first opening (22), thus obtaining a certain range of coupling values.

15

20

25

30

35

40

45

50

55

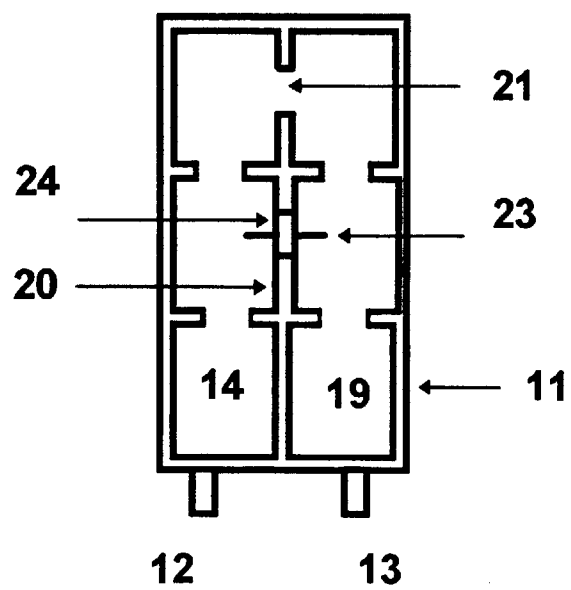


FIG. 1

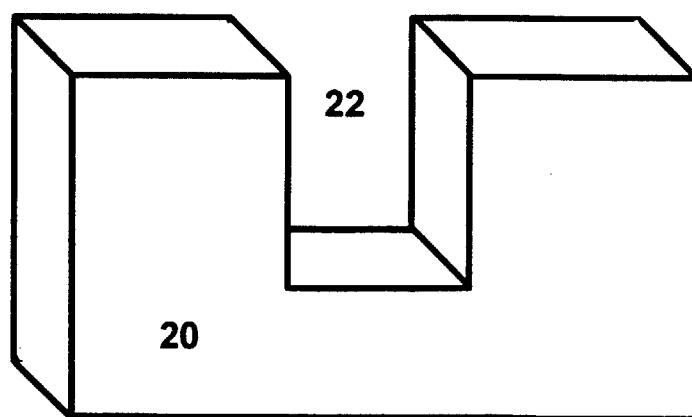


FIG. 2

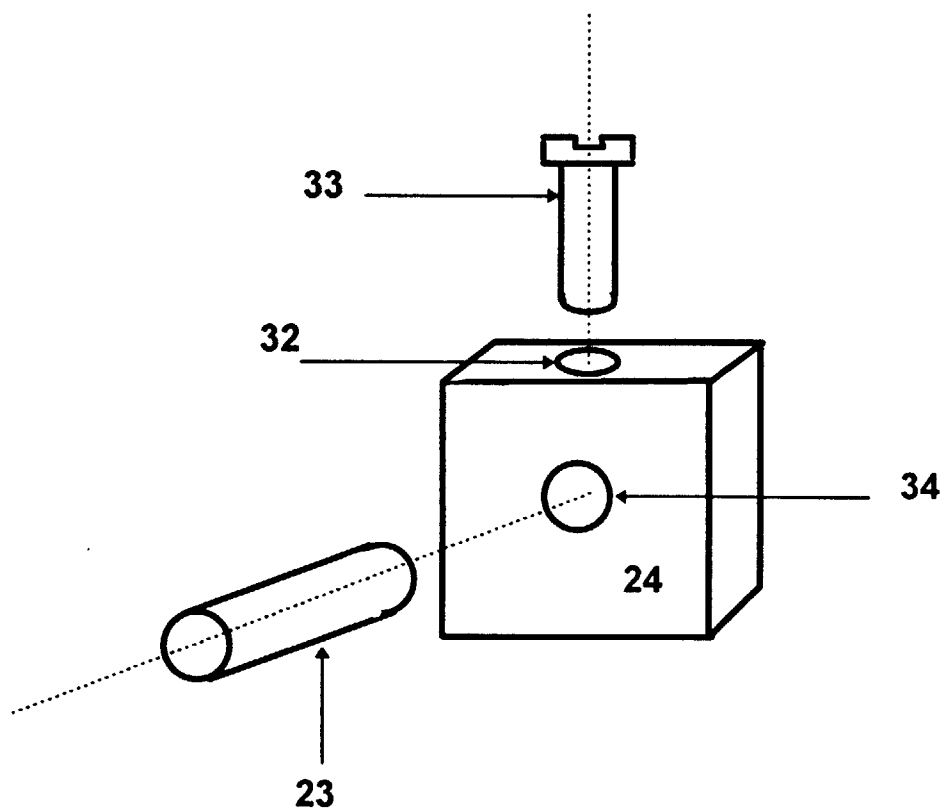


FIG. 3