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(54) **RF filter with coupling means for RF signals**

(57) The invention relates to a filter for radio frequency signals comprising a first resonator (RC1 and first coupling means (CP1) for coupling the radio frequency signals between the outside of the filter (F1) and the first resonator (RC1), the first resonator (RC1) comprises a

first resonator rod (RR1), and the first resonator rod (RR1) is part of a supply line for providing RF signals from an input of said filter to said first coupling means (CP1) or is part of an output transfer line for providing RF signals from said first coupling means (CP1) to an output of said filter.

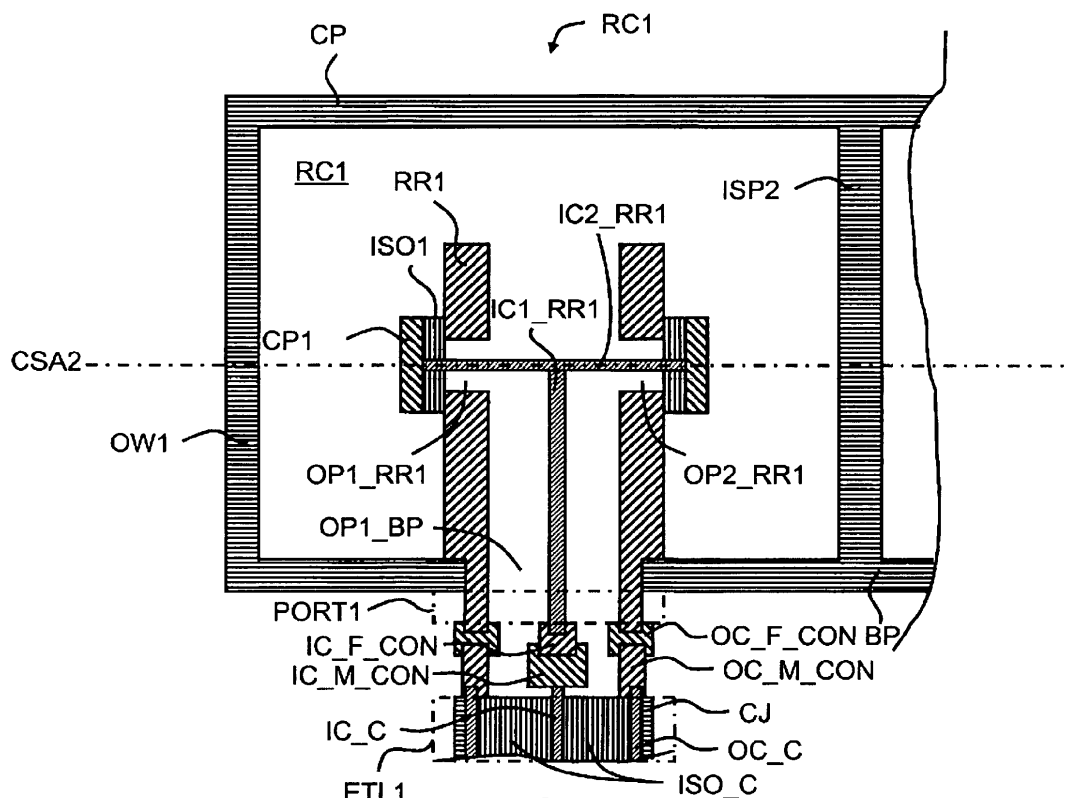


FIG. 2

Description

FIELD OF THE INVENTION

[0001] The invention relates to a filter for radio frequency signals and, more particularly but not exclusively, to a filter comprising at least one coaxial resonator.

BACKGROUND

[0002] Filters are used for example in radio communication systems to keep radio frequency transmissions within a specific radio frequency sub-range for avoiding interference and/or noise in neighbouring radio frequency sub-ranges or for keeping the interference and/or the noise below specific thresholds, which may depend on legal requirements or on wireless communication specifications.

[0003] Characteristics of a filter such as a bandpass filter are for example a maximum allowed deviation from a required passband frequency bandwidth or a minimum required signal suppression for example in dB outside a passband of the bandpass filter irrespective of a centre frequency of the passband within a specified filter tuning range. These characteristics are major design criteria for bandpass filters, if the bandpass filters have to fulfil the legal requirements and/or the wireless communication specifications.

[0004] Based on an arrangement of electromagnetic coupling structures within the filter having an electromagnetic coupling of present state of the art, a frequency selectivity of the filter may degrade and may therefore not fulfil specific legal emission requirements or the wireless communication specifications.

[0005] In on RF filter (RF = radio frequency) comprising coaxial resonators with enclosed hollow spaces as an outer conductor and comprising resonator rods as inner conductors, a first orientation of a supply line of input couplings and a second orientation of an output transfer line of output couplings are often applied in a perpendicular direction with respect to a longitudinal axis of the resonator rods of an input coaxial resonator and an output coaxial resonator. Such an arrangement could provide an unwanted direct coupling from the input and/or output couplings to neighboring coaxial resonators of the input and/or the output coaxial resonator. Thereby, the frequency selectivity of the filter may be disturbed and may be outside destined specifications.

[0006] In another arrangement, a resonator rod extends from a base plate and a capacitive coupling is provided from a cover plate using an end piece of a supply line or an output transfer line with a capacitive probe. This type of coupling has several disadvantages especially if the RF filter is used for high-power applications. The capacitive probe is located at an open end of the resonator rod, which is the most sensitive location of a coaxial resonator in terms of a resonant frequency of the coaxial resonator. Any instability of the coupling such as

tumbling caused by connector tightening or bending forces from connected structures leads to severe detuning of the coaxial resonator and to an RF filter not fulfilling specifications. Furthermore, the location of the capacitive probe reduces a maximum peak power handling of the coaxial resonator and of the RF filter because the presence of the capacitive probe increases the electrical field strength especially at edges of the capacitive probe and at a location, where the electrical field strength within the coaxial resonator has a maximum.

SUMMARY

[0007] The way of coupling RF signals to and from an RF filter comprising at least one coaxial resonator affects a compactness and dimensions of the RF filter, a power handling of the RF filter, and accidentally also a spectral characteristic of the RF filter.

[0008] Therefore, it is an object of the invention to provide an RF filter with reduced dimensions, with an improved power handling, and also with an improved spectral characteristic.

[0009] The object is achieved by a filter for radio frequency signals comprising a first resonator and first coupling means for coupling the radio frequency signals between the outside of the filter and the first resonator. The first resonator comprises a first resonator rod and the first resonator rod is part of a supply line for providing the radio frequency signals from an input of the filter to the first coupling means or an output transfer line for providing the radio frequency signals from the first coupling means to an output of the filter.

[0010] The filter may be for example a bandpass filter and the first resonator may be for example a coaxial air cavity resonator.

[0011] Preferably, the first resonator may be a transverse electromagnetic wave mode resonator.

[0012] The invention has a first benefit of improving a mechanical stability of the components of the RF filter and thereby improving a stability and a predictability of a frequency selectivity of the RF filter. An insufficient rejection of RF signals by the RF filter outside a specified frequency range or an attenuation of RF signals inside a passband can be avoided.

[0013] The invention provides a second benefit of increasing a maximum power handling of the RF filter and of decreasing a likelihood of any unwanted electrical contact.

[0014] The invention provides a third benefit of avoiding a direct coupling of the RF signals from the input and/or output couplings to neighboring coaxial resonators of the input and/or the output coaxial resonator of the RF filter. The invention provides a fourth benefit of increasing a compactness of the RF filter.

[0015] The invention provides a fifth benefit of lowering manufacturing complexity/cost, because separate alignments for the capacitive probe and for the resonator rod within the resonator can be performed in an easier way.

If the capacitive probe is already mounted to the resonator rod, the capacitive probe is already pre-aligned to some extent at that time the resonator rod is mounted.

[0016] Further advantageous features of the invention are defined and are described in the following detailed description of the invention.

BRIEF DESCRIPTION OF THE FIGURES

[0017] The embodiments of the invention will become apparent in the following detailed description and will be illustrated by accompanying figures given by way of non-limiting illustrations.

Figure 1 shows schematically a block diagram of a filter in a cross-sectional view according to an embodiment of the invention.

Figure 2 shows schematically a block diagram of a resonator of the filter in a cross-sectional view according to the embodiment of the invention.

Figure 3 shows schematically a block diagram of a further filter in a cross-sectional view according to a further embodiment of the invention.

DESCRIPTION OF THE EMBODIMENTS

[0018] Figure 1 shows schematically in a block diagram and in a cross-sectional view a filter F1 according to a preferred embodiment of the invention. The cross-sectional view is perpendicular to a base plate of the filter F1 and a cover plate of the filter F1 and the cross section of the cross-sectional view is located within the filter F1 between the base plate and the cover plate. The detailed structure of the filter F1 is not critical, and as can be understood by those skilled in the art, that the detailed structure of the filter F1 may vary without departing from the scope of the invention.

[0019] The filter F1 may be for example a band-pass filter for radio frequency signals of a broadcasting service or may be applied in a transmission path of a base station for use in a network of a telecommunication service provider.

[0020] The filter F1 may be for example a high-power radio broadcasting filter adapted to a frequency band with a frequency tuning range between 470 MHz and 860 MHz.

[0021] Alternatively, the filter F1 may be applied in a transmission and/or reception path of a base station of a mobile radio network using a radio access technology such as GSM/GPRS (GSM = Global System for Mobile Communication, GPRS = General Packet Radio Service), UMTS (UMTS = Universal Mobile Telecommunication Systems), or LTE (LTE = Long Term Evolution). Exemplarily the filter F1 may be adapted to 900 MHz or 1800 MHz frequency bands of GSM or to frequency bands specified for UMTS, WiMAX (WiMAX = Worldwide Interoperability for Microwave Access), and/or LTE.

[0022] The filter F1 may comprise a first resonator

RC1, a second resonator RC2, a third resonator RC3, a fourth resonator RC4, a fifth resonator RC5 and a sixth resonator RC6 arranged in a U-shaped order with a U-shaped resonator path (a so-called 'folded filter' design) as indicated in Figure 1 by a dotted arrow AR.

[0023] The resonators RC1 to RC6 may be preferably coaxial air-cavity resonators and may have preferably identical geometrical dimensions. The resonators RC1 to RC6 are well-known as transverse electromagnetic wave mode resonators.

[0024] Alternatively, the filter F1 may comprise less than six resonators or more than six resonators. In a further alternative, the resonators RC1 to RC6 may be arranged in a linear or straight-form.

[0025] In even further alternatives, the resonators RC1 to RC6 may be arranged in an S-shaped order or an arrangement of the resonators RC1 to RC6 may comprise a combination of resonators in a U-shaped order and of further resonators in an S-shaped order.

[0026] A housing of the filter F1 as exemplarily shown in Figure 1 comprises a first outer wall OW1 next to the resonators RC1 and RC6, a second outer wall OW2 next to the resonators RC4, RC5 and RC6, a third outer wall OW3 next to the resonators RC3 and RC4 and a fourth outer wall OW4 next to the resonators RC1, RC2 and RC3.

[0027] The housing further comprises a first inner separating wall ISP1 between the resonators RC1 and RC2, a second inner separating wall ISP2 between the resonators RC2 and RC3, a third inner separating wall ISP3 between the resonators RC3 and RC4, a fourth inner separating wall ISP4 between the resonators RC4 and RC5, a fifth inner separating wall ISP5 between the resonators RC5 and RC6, a sixth inner separating wall ISP6 between the resonators RC1 and RC6 and a seventh inner separating wall ISP7 between the resonators RC2 and RC5.

[0028] The base plate, the outer walls OW1 to OW4, the inner separating walls ISP1 to ISP7 and the cover plate form separate hollow spaces for the resonators RC1 to RC6.

[0029] The housing of the filter F1 is used as an outer conductor for the RF signals and resonator rods RR1 to RR6 located within the resonators RC1 to RC6 are used as inner conductors for the RF signals.

[0030] Conductive couplings means such as capacitive probes mounted at the inner separating walls ISP1 to ISP7 and/or inductive coupling means such as coupling loops mounted within openings of the inner separating walls ISP1 to ISP7 for electromagnetic coupling in each case between two of the resonators RC1 to RC6 are not shown in Figure 1 for simplification. Such couplings are known to a person skilled in the art and are therefore not further explained in the following.

[0031] Each of the resonator rods RR1, RR2, RR3, RR4, RR5, RR6 is preferably located centrally within one of the resonators RC1, RC2, RC3, RC4, RC5, RC6 (see Figure 1) and extends upwards from the base plate. Pref-

erably, second, third, fourth and fifth resonator rods RR2 to RR5 are solid resonator rods comprising a cylindrical form as shown in Figure 1. Alternatively, the resonator rods RR2 to RR5 may comprise a form of a hollow cylinder.

[0032] The first resonator rod RR1 within the first resonator RC1 being the input resonator preferably comprises the form of a hollow cylinder as shown in Figure 1 and is part of a supply line for first coupling means CP1 used as input coupling means. The first coupling means CP1 are preferably, capacitive coupling probes for coupling the RF signals from the outside of the filter F1 via an input port of the filter F1 to the first resonator RC1. More details according to the first resonator rod RR1, the supply line and the first coupling means CP1 are given in the following description according to Figure 2.

[0033] The sixth resonator rod RR6 within the sixth resonator RC6 being the output resonator preferably also comprises the form of a hollow cylinder as shown in Figure 1 and is part of an output transfer line for sixth coupling means CP6 used as output coupling means. The sixth coupling means CP6 are preferably capacitive coupling probes for coupling the radio frequency signals from the sixth resonator RC6 via an output port of the filter F1 to the outside of the filter F1.

[0034] In further alternatives (not shown in Figure 1), either the first resonator rod RR1 or the sixth resonator rod RR6 may be a solid resonator rod similar to the second to fifth resonator rods RR2 to RR5 as shown in Figure 1. In such cases, the filter F1 may comprise an external port at the first outer wall OW1 and an opening in the first outer wall OW1 either for coupling the RF signals from the outside of the filter F1 into the first resonator RC1 or for coupling the RF signals from the sixth resonator RC6 to the outside of the filter F1. These further alternatives mean that the use of the first resonator rod RR1 as part of the supply line for the first coupling means CP1 or the use of the sixth resonator rod RR1 as part of the output transfer line for the sixth coupling means CP6 may be applied only for the input port or the output port of the filter F1 and the other port uses conventional coupling mechanisms as mentioned in the background section.

[0035] Figure 2 shows schematically a block diagram of the first resonator RC1 in a cross-sectional view with respect to a first cross section area CSA1 indicated in Figure 1. The elements shown in Figure 2 that correspond to elements of the Figure 1 have been designated by the same reference numerals.

[0036] Figure 2 shows mainly the first resonator RC1 with an assembly of the first resonator rod RR1 and of the first coupling means CP1, the base plate BP, the cover plate CP, the second inner separating wall ISP2 and electrical connection means for the first coupling means CP1. A second cross section area CSA2 of the cross-sectional view as shown in Figure 1 is also indicated.

[0037] The hollow cylinder of the first resonator rod RR1 may stick out from the first resonator RC1 to the outside of the filter F1 and may comprise a first outer

diameter inside the first resonator RC1 and may comprise a second outer diameter smaller than the first outer diameter inside the base plate BP and outside the filter F1. Thereby, a part of the first resonator rod RR1 may be part of a first external port PORT1 for connecting a first external transmission line ETL1 such as a coaxial cable for providing the RF signals to the filter F1.

[0038] The second outer diameter may comprise an external thread and an opening OP1_BP within the base plate BP may comprise an internal thread for fixing the first resonator rod RR1 to the base plate BP.

[0039] In further alternatives, the first resonator rod RR1 may only comprise a single outer diameter and/or the first resonator rod RR1 may be soldered or welded to the base plate BP.

[0040] In an even further alternative, a separate device may be used as the first external port, may penetrate the base plate BP (instead of the first resonator rod RR1) and may be connected to the first resonator rod RR1 for example near an inner surface of the base plate BP.

[0041] The hollow cylinder of the first resonator rod RR1 may comprise a material such as aluminium or copper and is used as an outer conductor of a coaxial transmission line and is connected to an external electrical supply line for the first coupling means CP1.

[0042] The hollow cylinder of the first resonator rod RR1 may further comprise in a sidewall two openings OP1_RR1, OP2_RR2 for example at same distance to the base plate BP and the cover plate CP. The two openings OP1_RR1, OP2_RR2 may be for example circular openings.

[0043] In an alternative, the hollow cylinder of the first resonator rod RR1 may comprise in the sidewall a single opening or more than two openings.

[0044] The first resonator rod RR1 may further comprise centrally within the hollow cylinder and in a longitudinal direction of the hollow cylinder a first inner conductor IC1_RR1. The first inner conductor IC1_RR1 may extend from a second inner conductor IC2_RR1 between the two openings OP1_RR1, OP2_RR2 through the opening OP1_BP of the base plate BP to the outside of the filter F1. The second inner conductor IC2_RR1 may be vertically orientated to the longitudinal axis of the hollow cylinder, may penetrate the two openings OP1_RR1, OP2_RR2 and electrically connects the first coupling means CP1. The first inner conductor IC1_RR1 is electrically connected to the second inner conductor IC2_RR1 for example by soldering, welding or clamping.

[0045] The first and the second inner conductor IC1_RR1, IC2_RR1 may be preferably a stiff hollow or solid copper silver or aluminium rod.

[0046] The second inner conductor IC2_RR1 may be electrically connected to the first coupling means CP1 for example by soldering, welding or screwing.

[0047] In a further alternative, a single inner conductor instead of the first inner conductor IC1_RR1 and the second inner conductor IC2_RR1 may electrically connect the first coupling means CP1 via a single opening in the

sidewall of the first resonator rod RR1 to the first external port PORT1.

[0048] The first coupling means CP1 may be preferably a ring comprising a material such as aluminium, copper or silver and with a plane parallel orientated to a surface of the base plate BP.

[0049] In principle an air gap between the first coupling means CP1 and the hollow cylinder of the first resonator rod RR1 can be used as electrical isolation and no additional isolation is required between the first coupling means CP1 and the hollow cylinder of the first resonator rod RR1.

[0050] But alternatively, an isolator ISO1 (as shown in Figure 2) may be applied between the first coupling means CP1 and the hollow cylinder of the first resonator rod RR1.

[0051] The isolator ISO1 may be for example a ring with an outer diameter equal or slightly smaller than an inner diameter of the first coupling means CP1 and the isolator ISO1 may comprise a material suitable for isolation of RF signals such as glass, porcelain, or composite polymer materials (e.g. polytetrafluorethylen).

[0052] Preferably, the isolator ISO1 comprises two openings for feed through the second inner conductor IC2_RR1 as shown in Figure 2.

[0053] Alternatively, instead of the first coupling means CP1 being circular rings first coupling means Cup1_2 using two circular disks may be applied with a central axis directed towards the first inner separating wall ISP1 and the outer wall OW1 and perpendicular to a central axis of the first resonator rod RR1 such as shown in Figure 3 for a filter F2. Each of the two circular disks is located at one of the openings OP1_RR1, OP2_RR1 and may be arranged with its axis superimposed to a longitudinal axis of second inner conductor IC2_RR1. In Figure 3, circular disks are also applied for sixth coupling means CP6_2 of the sixth resonator RC6.

[0054] The first coupling means CP1 are preferably mounted laterally to the first resonator rod RR1.

[0055] A strength of the coupling of the first coupling means CP1 and a loaded quality factor of the first resonator RC1 for a predefined frequency response of the filter F1 is adjusted by appropriate dimensions of the first coupling means CP1. Such dimensions can be calculated for a person skilled in the art by following equation for a capacitance of a cylindrical capacitor:

$$C = 2 \cdot \pi \cdot \epsilon_0 \cdot L / \ln(b/a)$$

with:

epsilon-0: free space permittivity

L: height of the ring

b: inner diameter of the ring

a: outer diameter of the first resonator rod RR1

C: capacitance

[0056] For further calculation of geometrical dimensions of the first coupling means CP1 for a specific frequency range of the filter F1 simulation software tools such as Ansoft HFSS or CST MWS may be used by a person skilled in the art.

[0057] Fine tuning of the coupling can be achieved by adjusting a distance between the first coupling means CP1 and the base plate BP.

[0058] The first external port PORT1 of the filter F1 may be a coaxial connection port and may be connected to the first external transmission line ETL1 by a female connector and a male connector. Preferably, a central longitudinal axis of the first external port PORT1 is perpendicular to the base plate BP and is equal (or in a coaxial relationship) to a central longitudinal axis of the first resonator rod RR1. With respect to the dotted arrow AR shown in Figure 1, the first external port PORT1 may be an input port of the filter F1 for the radio frequency signals.

[0059] The first external transmission line ETL1 such as a coaxial cable comprises an inner conductor IC-C, a concentric outer conductor OC_C surrounding the inner conductor IC - C, an isolator ISO_C between the inner conductor IC-C and the outer conductor OC_C and a cable jacket CJ surrounding the outer conductor OC-C.

[0060] An inner conductor IC_F_CON of the female connector may be electrically connected to the first inner conductor IC1_RR1 of the resonator rod RR1 and an outer conductor OC-F-CON of the female connector may be electrically connected to the hollow cylinder of the resonator rod RR1 for example by soldering or welding.

[0061] An inner conductor IC-M-CON of the male connector may be electrically connected to the inner conductor IC_C of the first external transmission line ETL1 and an outer conductor OC_M_CON of the male connector may be electrically connected to the outer conductor OC_C of the first external transmission line ETL1 for example by soldering or welding.

[0062] The inner conductors IC_F_CON, IC_M_CON of the female and male connector and the outer conductors OC_F_CON, OC_M_CON of the female and male connector may be connected for example by clamping or screwing.

[0063] The assembly of the connection between the inner and outer conductors is shown in a simplified way. Any conventional connection assembly may be used for connecting the first external transmission line ETL1 to the first external port PORT1 of the filter F1.

[0064] Preferably, an additional isolator material such as polytetrafluoroethylene (PTFE, well-known as Teflon) may be applied to fill out a hollow space between the first inner conductor IC1_RR1 and the inner surface of the first resonator rod RR1 and may extend from the isolator ISO_C into the first resonator RC1.

[0065] The resonance within the first resonator RC1 and the coupling from the outside of the filter F1 to the first resonator RC1 may be adjusted for example by a tuning screw penetrating the cover plate CP of the filter

F1 (not shown in Figure 1 for simplification reasons).

[0066] In summary, the first resonator rod RR1 has two functions:

1. An outer surface of the first resonator rod RR1 is used as the inner conductor of the filter F1.
2. An inner surface of the first resonator rod RR1 is used as an outer conductor for a coaxial input of the RF signals from the outside of the filter F1 to the first resonator Roc1.

[0067] A same assembly as shown in Figure 2 and explained above for the first resonator RC1 may be applied for the sixth resonator RC6 for the output of the filter F1. With respect to the dotted arrow AR shown in Figure 1, a second external port provided by the sixth resonator rod RR6 is the output port of the filter F1.

Claims

1. A filter (F1, F2) for radio frequency signals comprising a first resonator (RC1, RC6) and first coupling means (CP1, CP1_2, CP6, CP6_1) for coupling said radio frequency signals between the outside of said filter (F1, F2) and said first resonator (RC1, RC6), said first resonator (RC1, RC6) comprises a first resonator rod (RR1, RR6), and said first resonator rod (RR1, RR6) is part of a supply line for providing said radio frequency signals from an input (PORT1) of said filter (F1, F2) to said first coupling means (CP1, CP1_2) or is part of an output transfer line for providing said radio frequency signals from said first coupling means (CP6, CP6_1) to an output of said filter (F1, F2).
2. Filter (F1) according to claim 1, wherein said filter (F1) comprises a first external port (PORT1) connected to said first coupling means (CP1, CP6) and wherein a central axial axis of said first resonator rod (RR2, RR6) is equal to a central axial axis of said first external port (PORT1).
3. Filter (F1, F2) according to any of the preceding claims, wherein said first resonator rod (RR1, RR6) is a hollow cylinder, wherein said hollow cylinder is an outer conductor of a coaxial transmission line, and wherein said hollow cylinder comprises in a hollow space of said hollow cylinder an inner conductor (IC1_RR1, IC2_RR1) of said coaxial transmission line connected to said first coupling means (CP1, CP1_2, CP6, CP6_2).
4. Filter (F1, F2) according to claim 3, wherein said first coupling means (CP1, CP1_2, CP6, CP6_2) are electrically connected to said inner conductor (IC2_RR1) through at least one opening (OP1_1, OP1_2) in a sidewall of said hollow cylinder.
5. Filter (F1, F2) according to any of the preceding claims, wherein said first coupling means (CP1, CP1_2, CP6, CP6_2) are laterally mounted to said first resonator rod (RR1, RR6).
6. Filter (F1) according to claim 5, wherein said first coupling means (CP1, CP6) is a ring around said first resonator rod (RR1, RR6).
7. Filter (F1, F2) according to any of the preceding claims, wherein said filter (F1, F2) further comprises a second resonator (RC1, RC6) and second coupling means (CP1, CP1_2, CP6, CP6_2) for coupling said radio frequency signals between said outside of said filter (F1, F2) and said second resonator (RC1, RC6), wherein said second resonator (RC1, RC6) comprises a second resonator rod (RR1, RR6), and wherein said second resonator rod (RR1, RR6) is part of an output transfer line of said second coupling means (CP1, CP1_2, CP6, CP6_2), if said first resonator rod (RR1, RR6) is part of a supply line or is part of a supply line of said second coupling means (CP1, CP1_2, CP6, CP6_2), if said first resonator rod (RR1, RR6) is part of an output transfer line.
8. Filter (F1) according to claim 7, wherein said supply line is connected to an input port (PORT1) of said filter (F1) and wherein said output transfer line is connected to an output port of said filter (F1).
9. Filter (F1, F2) according to any of the preceding claims, wherein said filter (F1, F2) is a band-pass filter.
10. Filter (F1, F2) according to any of the preceding claims, wherein said first resonator (RC1, RC6) is a coaxial transverse electromagnetic wave mode resonator.
11. Filter (F1, F2) according to any of the preceding claims, wherein said first resonator (RC1, RC6) is an air-cavity resonator.
12. Filter (F1, F2) according to any of the preceding claims, wherein said filter (F1, F2) is a high-power radio broadcasting filter or a high-power television broadcasting filter.
13. A base station for use in a radio communication system comprising a filter (F1, F2) according to any of the preceding claims.

Amended claims in accordance with Rule 137(2) EPC.

1. A filter (F1, F2) for radio frequency signals comprising a first resonator (RC1, RC6) and first coupling

means (CP1, CP1_2, CP6, CP6-1) for coupling said radio frequency signals between the outside of said filter (F1, F2) and said first resonator (RC1, RC6), said first resonator (RC1, RC6) comprises a first resonator rod (RR1, RR6), said first resonator rod (RR1, RR6) is part of a supply line for providing said radio frequency signals from an input (PORT1) of said filter (F1, F2) to said first coupling means (CP1, CP1_2) or is part of an output transfer line for providing said radio frequency signals from said first coupling means (CP6, CP6_1) to an output of said filter (F1, F2), said first resonator rod (RR1, RR6) is a hollow cylinder, wherein said hollow cylinder is an outer conductor of a coaxial transmission line, and said hollow cylinder comprises in a hollow space of said hollow cylinder an inner conductor (IC1_RR1, IC2_RR1) of said coaxial transmission line connected to said first coupling means (CP1, CP1_2, CP6, CP6_2),

characterized in that said first coupling means (CP1, CP1_2, CP6, CP6_2) are electrically connected to said inner conductor (IC2_RR1) through at least one opening (OP1_1, OP1_2) in a curved side-wall of said hollow cylinder and are laterally mounted to said hollow cylinder.

2. Filter (F1) according to claim 1, wherein said filter (F1) comprises a first external port (PORT1) connected to said first coupling means (CP1, CP6) and wherein a central axial axis of said first resonator rod (RR1, RR6) is equal to a central axial axis of said first external port (PORT1).

3. Filter (F1, F2) according to claim 1, wherein said at least one opening (OP1_1) and a further opening (OP1_2) are located at a same distance to a base plate (BP) of a housing of said filter (F1, F2) and to a cover plate (CP) of said housing.

4. Filter (F1) according to claim 1, wherein an isolator (ISO1) is applied between said first coupling means (CP1, CP6) and said hollow cylinder.

5. Filter (F1) according to claim 1, wherein said first coupling means (CP1, CP6) is a ring around said first resonator rod (RR1, RR6).

6. Filter (F2) according to claim 1, wherein said first coupling means (CP1_2, CP6_2) are two circular disks with a central axis directed towards a first inner separating wall (ISP1) of a housing of said filter (F2) and to an outer wall (OW1) of said housing and perpendicular to a central axis of said first resonator rod (RR1, RR6).

7. Filter (F1, F2) according to any of the preceding claims, wherein said filter (F1, F2) further comprises a second resonator (RC1, RC6) and second coupling

means (CP1, CP1_2, CP6, CP6_2) for coupling said radio frequency signals between said outside of said filter (F1, F2) and said second resonator (RC1, RC6), wherein said second resonator (RC1, RC6) comprises a second resonator rod (RR1, RR6), and wherein said second resonator rod (RR1, RR6) is part of an output transfer line of said second coupling means (CP1, CP1_2, CP6, CP6_2), if said first resonator rod (RR1, RR6) is part of a supply line or is part of a supply line of said second coupling means (CP1, CP1_2, CP6, CP6_2), if said first resonator rod (RR1, RR6) is part of an output transfer line.

8. Filter (F1) according to claim 7, wherein said supply line is connected to an input port (PORT1) of said filter (F1) and wherein said output transfer line is connected to an output port of said filter (F1).

9. Filter (F1, F2) according to any of the preceding claims, wherein said filter (F1, F2) is a band-pass filter.

10. Filter (F1, F2) according to any of the preceding claims, wherein said first resonator (RC1, RC6) is a coaxial transverse electromagnetic wave mode resonator.

11. Filter (F1, F2) according to any of the preceding claims, wherein said first resonator (RC1, RC6) is an air-cavity resonator.

12. Filter (F1, F2) according to any of the preceding claims, wherein said filter (F1, F2) is a high-power radio broadcasting filter or a high-power television broadcasting filter.

13. A base station for use in a radio communication system comprising a filter (F1, F2) according to any of the preceding claims.

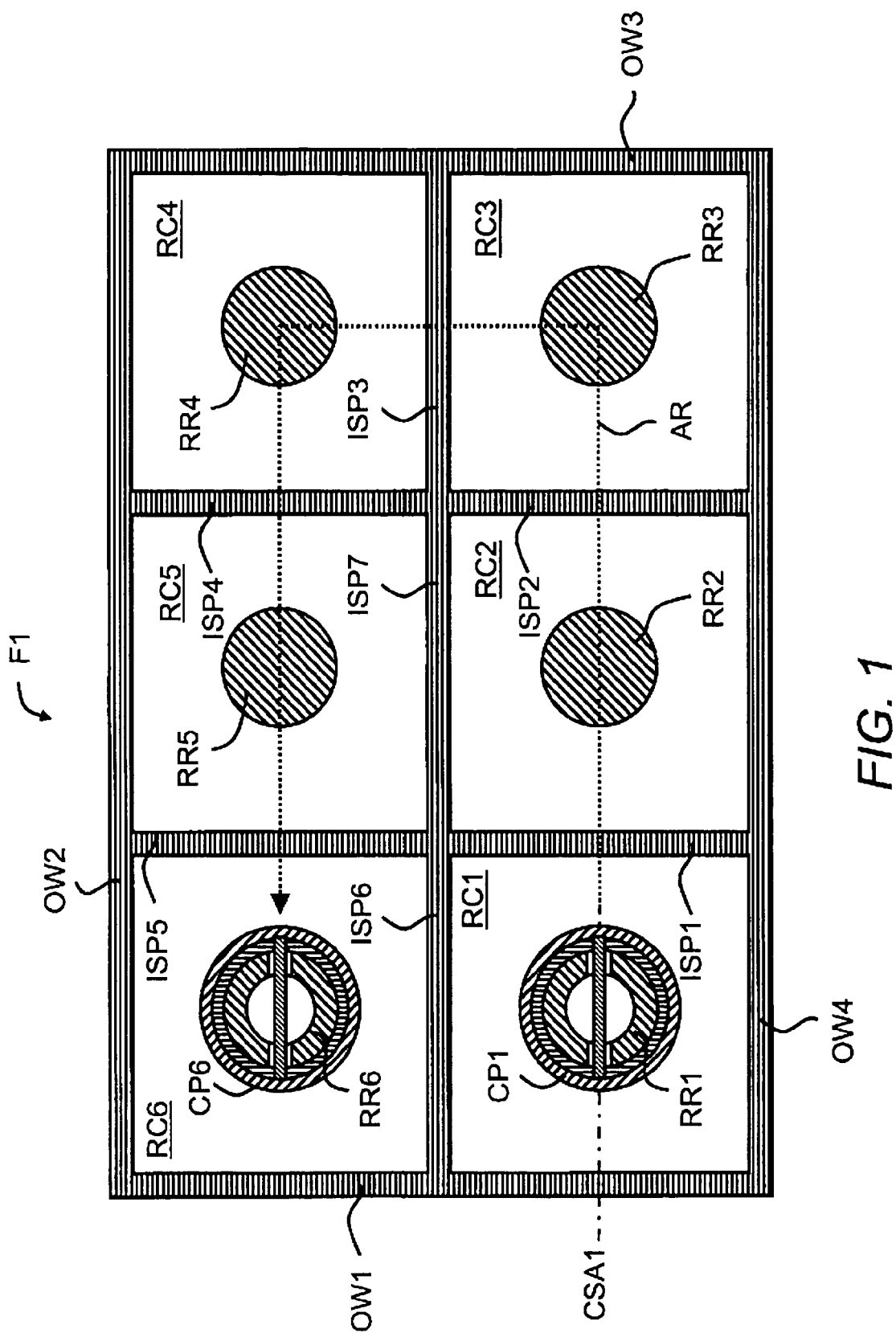


FIG. 1

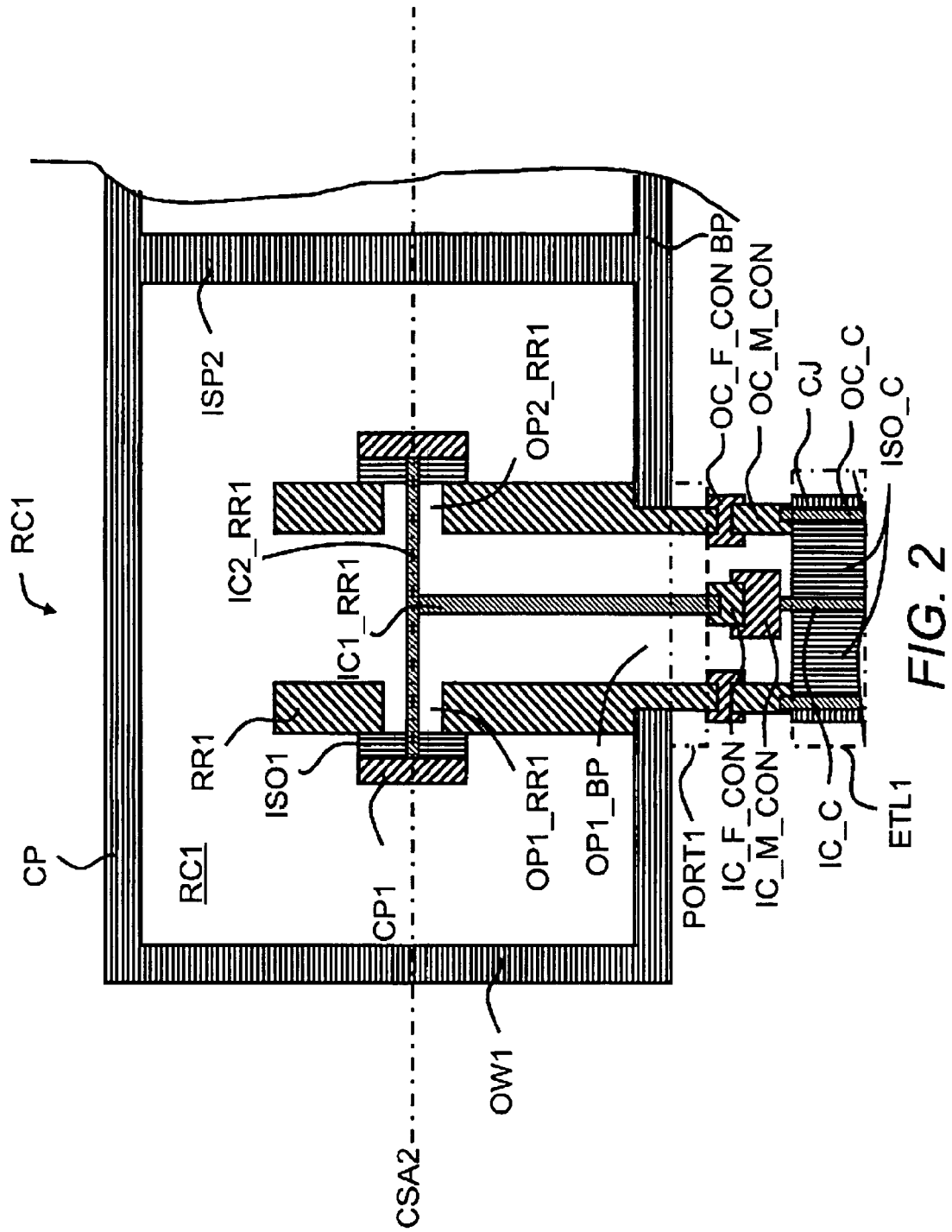


FIG. 2

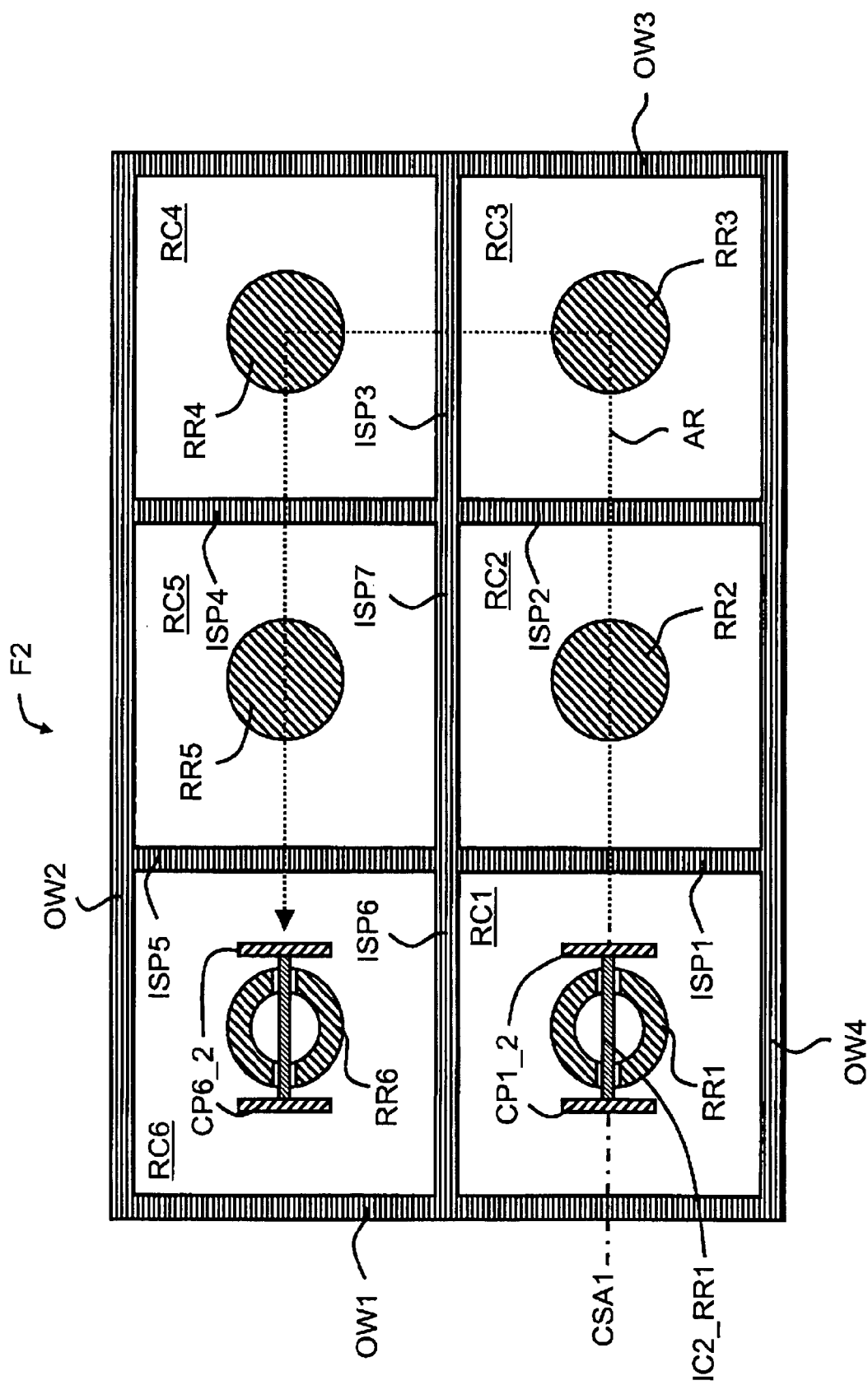


FIG. 3



EUROPEAN SEARCH REPORT

Application Number
EP 11 29 0044

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 7 July 2011	Examiner Ribbe, Jonas
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
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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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07-07-2011

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