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

(54) **Resonant assembly**

(57) A resonator assembly is disclosed. The resonator assembly comprises a resonator having a first resonance post coaxially surrounded by a conductive enclosure defining a cavity, the first resonance post being operable to filter a signal at a first frequency and a second resonance post located within the cavity, the second resonance post being operable to filter a signal at a second

frequency. Through this approach it is possible to provide a single device which implements more than one independent resonance within the same cavity volume, allowing to build significantly smaller cavity filters, which avoids the need to provide separate devices, one for each frequency.

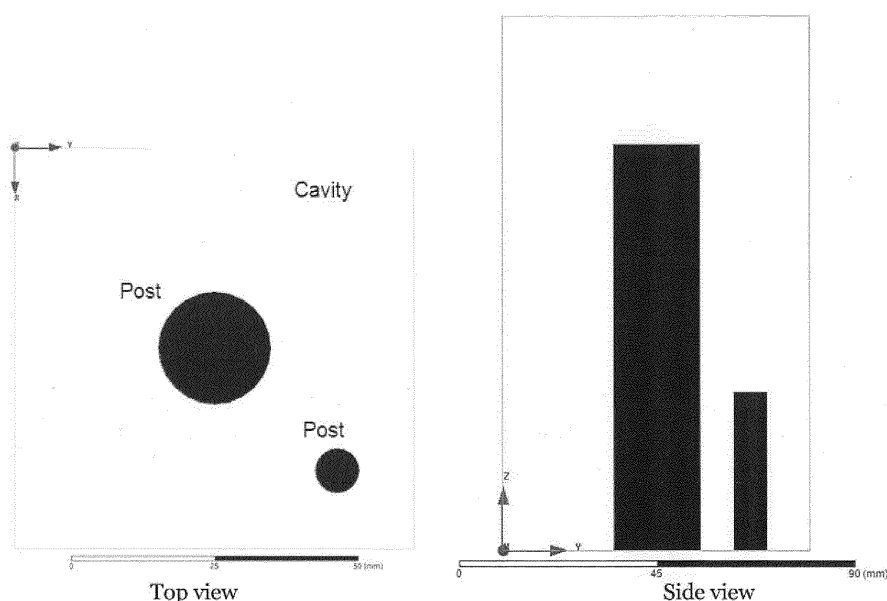


Figure 2: Configuration of proposed dual-frequency combline resonator

DescriptionFIELD OF THE INVENTION

5 **[0001]** The present invention relates to a resonant assembly.

BACKGROUND

10 **[0002]** Resonant devices are known. In low-frequency electronics, a resonant circuit contains a capacitor and a coil. The capacitor is used to store electrical energy and the coil stores magnetic energy. At resonance, energy stored in the resonant circuit is continuously converted between two states, swapping between capacitor and coil over time. At higher frequencies, transmission lines can resonate. A quarter-wavelength transmission line with one end grounded and the other end open can be seen as a combination of a capacitor and coil. Increasing the permittivity of the transmission line by using, for example, ceramic materials reduces the size of the resonant device. Resonant devices are often used in
15 radio-frequency (RF) front ends. Each resonant device has its own characteristics, including its own resonance frequency. The resonance frequency is dependent on the characteristics of the device and, in particular, on the characteristics of the mixtures of various materials making up the device.

[0003] It is desired to provide an improved resonant device.

SUMMARY

20 **[0004]** According to a first aspect, there is provided a resonator assembly, comprising: a resonator having a first resonance post coaxially surrounded by a conductive enclosure defining a cavity, the first resonance post being operable to filter a signal at a first frequency and a second resonance post located within the cavity, the second resonance post
25 being operable to filter a signal at a second frequency.

[0005] The first aspect recognises that conventional resonators such as, for example, a Transverse ElectroMagnetic (TEM) combine resonator shown in Figure 1, consists of a metallic cavity enclosure (with a generally circular-shaped or rectangular-shaped cross section) with a cylindrical-shaped metallic post at the centre of the circular/rectangular cavity grounded at one side and open-ended at the opposite side. Each of these resonators is dimensioned to provide
30 a resonance at a particular desired frequency. However, the first aspect recognises that it is possible to reuse the cavity in order provide a resonator which provides a resonance at more than one particular desired frequency.

[0006] Accordingly a resonator assembly may be provided. The assembly may comprise a resonator which has a first resonance post or element which may be surrounded or enclosed by a conductive enclosure or housing. The conductive enclosure may define a cavity. The first resonance post may resonate or filter a signal at a first frequency. The assembly
35 may comprise a resonator which has a second resonance post or element located within the cavity. The second resonance post may resonate or filter a signal at a second frequency. Through this approach it is possible to provide a single device which implements more than one independent resonance within the same cavity volume, allowing to build significantly smaller cavity filters, which avoids the need to provide separate devices, one for each frequency. This is particular convenient in resonant assemblies used in RF front ends which will often be required to receive signals at two different
40 frequencies.

[0007] In one embodiment, the first resonance post and the second resonance post upstand from the conductive enclosure. Accordingly, the posts may project or extend within the cavity.

[0008] In one embodiment, the second frequency is greater than the first frequency.

[0009] In one embodiment, harmonics of the first frequency fail to coincide with harmonics of the second frequency.

45 **[0010]** In one embodiment, the second frequency and the first frequency have no common harmonics.

[0011] In one embodiment, the first resonance post and the second resonance post have matching electrical lengths. It will be appreciated that the physical lengths may vary or may be the same depending on the frequency and the permittivity of the posts.

[0012] In one embodiment, the first resonance post is located centrally within the conductive enclosure and the second resonance post is located away from the first resonance post and towards the conductive enclosure. Accordingly, the
50 second resonance post may reuse part of the cavity.

[0013] In one embodiment, the first resonance post is operable to convey a signal using a first signal feed and the second resonance post is operable to convey a signal using a second signal feed, at least one of the first signal feed and the second signal feed being provided through a base of the conductive enclosure from which a respective one of
55 the first resonance post and the second resonance post upstands. Hence, the feed may be provided through a part of the enclosure which is other than a side-wall.

[0014] In one embodiment, the first resonance post and the second resonance post convey a signal using a common signal feed positioned between the first resonance post and the second resonance post. Accordingly, a single feed may

be provided to convey the signal simultaneously to each post.

[0015] In one embodiment, the common signal feed extends between a base of the conductive enclosure from which the first resonance post and the second resonance post upstands and a face of the conductive enclosure towards which the first resonance post and the second resonance post upstand.

[0016] In one embodiment, at least one of the first resonance post and the second resonance post is configured to have a variable length. In order to tune these two resonances independently, a dedicated tuning mechanism for each resonance is provided. By varying the length, the frequency may be tuned.

[0017] In one embodiment, at least one of the first resonance post and the second resonance post comprises a first portion displaceable with respect to a second portion to vary its length.

[0018] In one embodiment, the first portion is received within the second portion.

[0019] In one embodiment, the second portion comprises a post having a cavity extending therethrough for receiving the first portion therewithin.

[0020] In one embodiment, the first portion comprises a screw received within a screw thread formed within the cavity, the first portion being protrudable from the second portion to vary its length. As mentioned above, conventionally, in order to build filters with two or more resonances, individual physically separated filter cavities for each frequency band are built and these then are tuned independently. Conventionally, these resonances are tuned by tuning screws which protrude through a cavity wall or thorough the cavity cover into the cavity, located close to the region with the highest electrical field of the according resonant mode. However, this approach is often not possible or implies restrictions on the resonator layout, particularly for the resonant mode for the higher frequency which is excited on the shorter resonator post. For example, where the physical distance between the top end of the resonator-post is large, a long tuning screw would have a negative impact on the Q-factor of the resonator or would even result in a complete detuning of the resonator. In some cases it might be feasible to use a tuning screw from the side, but usually in more complex structures, e.g. in a filter-configuration, where several cavities are placed next to each other, this is not possible, since two rows of resonators are placed in parallel, making it impossible to place tuning screws from the side.

[0021] In one embodiment, the resonator assembly comprises a plurality of the resonators adjacently located and having shared portions of the conductive enclosure, and wherein the second resonance post in each resonance filter is located towards the shared portions of the conductive enclosure.

[0022] Further particular and preferred aspects are set out in the accompanying independent and dependent claims. Features of the dependent claims may be combined with features of the independent claims as appropriate, and in combinations other than those explicitly set out in the claims.

[0023] Where an apparatus feature is described as being operable to provide a function, it will be appreciated that this includes an apparatus feature which provides that function or which is adapted or configured to provide that function.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] Embodiments of the present invention will now be described further, with reference to the accompanying drawings, in which:

Figure 1 illustrates a Transverse ElectroMagnetic (TEM) combline resonator;

Figure 2 illustrates a dual-frequency combline resonator according to one embodiment;

Figure 3 illustrates the electric field distribution at resonance of the resonator of Figure 2;

Figure 4 illustrates the magnetic field distribution at resonance of the resonator of Figure 2;

Figures 5 and 6 illustrate feeding pin configurations according to embodiments;

Figure 7 illustrates tuning mechanisms according to embodiments;

Figure 8 illustrates a filter comprising a plurality of resonators according to one embodiment;

Figure 9 illustrates a tuning mechanism according to one embodiment; and

Figure 10 illustrates the independent control of the tuning for individual resonances utilizing the tuning screws.

DESCRIPTION OF THE EMBODIMENT

Overview

[0025] Before discussing the embodiments in any more detail, first an overview will be provided. An arrangement is provided where the cavity of a resonator is reused to co-house a further resonator. This provides a device which is able to provide resonance at multiple frequencies without needing to provide multiple devices, each with their own housing. Instead, the resonators are co-located within the same housing. This enables a single device to be provided which operates in same way as a plurality of different resonators, but with a significantly reduced size compared to providing separate resonators. Although the resonator structures can have similar permittivity and can vary their resonant frequency

by varying their length, varying the permittivity of the different resonator structures enables similar-sized structures to resonate at different frequencies. Also, although the embodiments described below provide for a two-frequency resonator, it will be appreciated that by adding additional resonator structures within the housing enables a more than two-frequency resonator to be provided.

Example Configuration

[0026] Figure 2 illustrates a dual-frequency combline resonator according to one embodiment. This arrangement utilizes the physical space provided by the single, in this example, rectangular, cavity provided in a combline package to include an additional metallic cylindrical post offset from a central location and towards a corner of the rectangular cavity. This is to introduce an additional electromagnetic resonance at a higher frequency. Although a rectangular package is shown, it will be appreciated that any other configuration which provides a coaxial arrangement between the metallic cylindrical post at the central location and a surrounding conductive enclosure could be used. Also, although the posts illustrated are cylindrical, it will be appreciated that non-cylindrical posts may be used.

[0027] In operation, this arrangement creates two electromagnetic (EM) resonances at distinct frequencies, f_1 (a lower frequency due to the centre metallic post) and f_2 (a higher frequency due to the corner metallic post). The centre metallic post within the rectangular metallic cavity with the corner metallic post present resonates at a frequency f_1 (which is slightly different to the frequency at which it would resonate if it were alone within the cavity), whereas the metallic post at the corner within the cavity with the metallic post at the centre present resonates at a higher desired frequency f_2 ($f_2 > f_1$). Due to the distinct and separated in spectrum resonances at f_1 and f_2 for a dual-resonance cavity, the corner metallic post's physical size is a fraction of the centre metallic post's size. This ratio is proportional (within limitations of the frequency ratio f_2/f_1 and specific technology implementation variations) to the ratio of frequencies f_1 and f_2 .

[0028] This arrangement enables two electromagnetic resonances at distinct frequencies in a single physical volume within a single metallic enclosure in a combline package. In addition this arrangement provides for dual-posts in a single cavity; a centre post for lower frequency operation and a corner post for higher frequency operation. Furthermore, this arrangement provides for the spatial separation of the resonance field distribution to allow for independent control of input/output coupling/tuning/inter-resonator coupling.

[0029] For optimal operation, the ratio of the frequencies (f_2/f_1) for the dual-resonance cavity should be selected so that the ratio (f_2/f_1) cannot be close to unity (i.e., the two frequencies cannot be very similar), since the two resonances cannot then be uncoupled as required for two distinct filtering functions to be realized. Also, for a combline package, the ratio between the frequencies cannot be close to 3, since the first higher order resonance $n \cdot f_1$ ($n=3$) of the low frequency resonance (f_1) will coincide with the second, high frequency fundamental mode resonance, (f_2). However, it will be appreciated that this is not a substantial problem for a number of dual-frequency applications (e.g., operating at 700 MHz and 1800 MHz).

[0030] An eigenmode analysis tool has been utilized to calculate the resonant frequency and Q-factor of the resonant structures considered. Ohmic losses are included in the simulations; silver has been considered for the cavity walls and copper for the posts (although other materials could be used). The results demonstrate that two resonant modes can be supported with this configuration and that these resonant modes closely correspond to the resonant modes of the individual standalone resonator modes of the low-band and high-band resonators.

[0031] Figures 3 and 4 show the EM field distribution for the two resonant modes.

[0032] Table 1 summarizes the resonant frequency and Q-factor of the first 3 eigenmodes of the standalone low-band combline resonator, standalone high-band resonator and combined resonator of Figure 2.

Table 1: Resonant frequency and Q-factor for the first 3 eigenmodes of the standalone low-band cavity, standalone high-band cavity, and combined low+high-band cavity

		Mode 1		Mode 2		Mode 3			
		f_0 (MHz)	Q_0	f_0 (MHz)	Q_0	f_0 (MHz)	Q_0		
Low		695.792	6407	2061.33	11389	2223.42	13850		
High		1792.12	4004	5237.13	7026	5722.69	8652		
		696.044	6186	f_0 (%)	1769.86	4449	f_0 (%)	2065.57	11243
Low +				0.04 U			1.24 D		0.26
High				Q_0 (%)			Q_0 (%)		
				3.45 D			11.1 U		

[0033] The low frequency resonance of the combined cavity resonator is not affected as compared to the standalone

low frequency cavity resonator. The Q-factor is slightly decreased (3.45 %). Similarly, the high-frequency resonance is not affected, whereas the Q-factor has been increased significantly (11.1 %). This is due to the greater electrical size of the host cavity. It is to be noted that the first harmonic resonance frequency of the standalone low-band resonator is not significantly affected by the inclusion of the high-band metallic post, thus does not create problems for the high-band resonance of the combined cavity.

Feeding Pin Configuration

[0034] Figures 5 and 6 illustrate three feeding pin configurations according to embodiments. Figures 5a/6a would be suitable for an inline configuration, Figures 5b/6b would suit a folded configuration and Figures 5c/6c show a suitable configuration for dual-band filters. A combination of Figures 5c/6c with either Figures 5b/6b or Figures 5a/6a would be suitable for a duplexer configuration. In Figures 5a/6a and 5b/6b, the inner core of the coaxial feed is shown coupled towards the base of each post. However, it will be appreciated that an alternative well-known approach would be instead to couple towards the top of the post via spaced coin or capacitive disc arrangement.

[0035] In the arrangement shown in Figures 5a/6a, the coaxial feed enters the cavity through the conductive wall. However, it is difficult to achieve a filter with desirable characteristics using this feed arrangement for a multi-stage resonator where resonators are arranged in series and each resonator is coupled to the next via adjoining portions of the conductive wall. Accordingly, Figures 5b/6b and 5c/6c provide alternative feed arrangements for such multi-stage resonators. In Figures 5b/6b, the coaxial feed for at least the offset post comes through the floor of the conductive enclosure. In Figures 5c/6c, the feed for both posts comes through the floor (or roof) of the conductive enclosure and feeds a conductive rod spatially separated from both posts, but which provides for EM coupling with both posts.

Tuning

[0036] Figure 7 illustrates an arrangement for tuning of the resonant frequencies. Unlike for the central resonator post where it is possible to tune its resonant frequency using a screw which projects towards the top of the post as shown in Figure 7, this approach is not practical for the offset resonator post as the long length of such a screw would affect the characteristics of the central resonator post. Also, it is not possible to provide a screw extending towards the offset resonator post through the conductive wall and still retain access to that screw in a multi-stage resonator as shown in Figure 8. Hence, in order to provide for tuning of the resonant frequencies, a tuning screw, which reaches through the resonator post, and out of the top of the resonator post is provided. This enables a change in the effective length of the resonator post and therefore allows for the tuning of the resonator frequency from the underside of the cavity. In a multi-stage resonator, this enables all resonators to be tuned from the underside, allowing for easy tuning of all resonators from one side.

[0037] As shown in Figure 9 there is provided a hollow resonator post, through which a screw from the underside passes through. The pass-through of the screw can be implemented in various ways, for example, with a thread at both ends of the resonator tube or only on the top end of the resonator post. The resonator post can be mounted to the resonator wall in different ways, for example, by a press-in-fit, by a thread or by soldering, other methods are possible. Also various methods can be used to ensure a good electrical and mechanical contact, for example, by spring loaded counter-screws at the bottom of the resonators post.

[0038] Since the electric field at the top of the post is strongest and therefore the current density in the according resonant frequency is minimal, the influence of the screw protruding through the resonator post top end on the quality factor of the resonator is minimal.

[0039] Figure 10 illustrates the independent control of the tuning for individual resonances utilizing the tuning screws. This is of paramount importance in order to achieve dual-frequency filter solutions with minimum tuning complexity comparable to the tuning complexity of the two distinct cavity/frequency filters.

[0040] Figure 10a shows the resonant frequency normalized to resonant frequency with no screw as a function of low-band screw penetration (mm) for low-band (solid line) and for high-band (dashed line). As can be seen, as the low-band screw changes the resonant frequency of the central resonant post, this has little effect on the resonant frequency of the offset resonant post. In particular, the high-band resonant frequency remains practically constant whereas the low-band frequency is tuned from approximately 0 - 4%.

[0041] Figure 10b shows the resonant frequency normalized to resonant frequency with no screw as a function of high-band screw penetration (mm) for high-band (solid line) and for low-band (dashed line). As can be seen, as the high-band screw changes the resonant frequency of the offset resonant post, this has little effect on the resonant frequency of the central resonant post. In particular, the low-band resonant frequency remains practically constant whereas the high-band frequency is tuned from approximately 0 - 4%.

[0042] Such an arrangement enables a resonator in a cavity which is relatively much higher than the resonator post is long, to be tuned mechanically and electrically in a very effective and simple way. If implemented on both resonators,

the tuning of both frequencies from only one side is possible; if implemented in such a way that one resonator is tuned from the top side and one from the lower side, this will reduce the density of screws on the respective side and allow for dense resonator configurations. This enables the construction of structures, which consist of multiple dual-resonance structures, which are not limited in their construction by requiring any tuning mechanisms from the side of the resonator. This allows the implementation of complex tuneable dual-resonance structures like filters in a very compact form factor, saving volume, weight and cost.

[0043] Accordingly, it can be seen that embodiments provide an arrangement having a reduced physical size but enabling two distinct resonant frequencies to coexist at the expense of slightly higher manufacturing and design complexity. Through this approach, no additional physical space is required for the high band resonant structure (f_2). Instead this is incorporated into the low band resonant structure (at f_1) without any additional physical space requirement. This provides an arrangement which offers high Q-factor (at f_2) with no additional physical space requirements. The additional physical space of the combined resonant structure allows for increase in the quality factor at the high frequency regime (f_2). This can allow for high performance filtering; required for narrow-band filter wireless telecommunication applications. The quality factors of the high frequency resonant structures are higher (represent lower ohmic losses) as compared with the standalone high filtering quality factors in the conventional filtering approaches. Also, due to the fact that additional physical space is inherent to the resonant structure for the high frequency, increase in the high power handling capabilities for terrestrial communication systems can be pursued. Furthermore, although there are additional costs of fabrication for a resonant structure at the high frequency there is an overall cost reduction due to the fact that only one resonant cavity needs to be fabricated instead of two.

[0044] A person of skill in the art would readily recognize that steps of various above-described methods can be performed by programmed computers. Herein, some embodiments are also intended to cover program storage devices, e.g., digital data storage media, which are machine or computer readable and encode machine-executable or computer-executable programs of instructions, wherein said instructions perform some or all of the steps of said above-described methods. The program storage devices may be, e.g., digital memories, magnetic storage media such as a magnetic disks and magnetic tapes, hard drives, or optically readable digital data storage media. The embodiments are also intended to cover computers programmed to perform said steps of the above-described methods.

[0045] The functions of the various elements shown in the Figures, including any functional blocks labelled as "processors" or "logic", may be provided through the use of dedicated hardware as well as hardware capable of executing software in association with appropriate software. When provided by a processor, the functions may be provided by a single dedicated processor, by a single shared processor, or by a plurality of individual processors, some of which may be shared. Moreover, explicit use of the term "processor" or "controller" or "logic" should not be construed to refer exclusively to hardware capable of executing software, and may implicitly include, without limitation, digital signal processor (DSP) hardware, network processor, application specific integrated circuit (ASIC), field programmable gate array (FPGA), read only memory (ROM) for storing software, random access memory (RAM), and non volatile storage. Other hardware, conventional and/or custom, may also be included. Similarly, any switches shown in the Figures are conceptual only. Their function may be carried out through the operation of program logic, through dedicated logic, through the interaction of program control and dedicated logic, or even manually, the particular technique being selectable by the implementer as more specifically understood from the context.

[0046] It should be appreciated by those skilled in the art that any block diagrams herein represent conceptual views of illustrative circuitry embodying the principles of the invention. Similarly, it will be appreciated that any flow charts, flow diagrams, state transition diagrams, pseudo code, and the like represent various processes which may be substantially represented in computer readable medium and so executed by a computer or processor, whether or not such computer or processor is explicitly shown.

[0047] The description and drawings merely illustrate the principles of the invention. It will thus be appreciated that those skilled in the art will be able to devise various arrangements that, although not explicitly described or shown herein, embody the principles of the invention and are included within its spirit and scope. Furthermore, all examples recited herein are principally intended expressly to be only for pedagogical purposes to aid the reader in understanding the principles of the invention and the concepts contributed by the inventor(s) to furthering the art, and are to be construed as being without limitation to such specifically recited examples and conditions. Moreover, all statements herein reciting principles, aspects, and embodiments of the invention, as well as specific examples thereof, are intended to encompass equivalents thereof.

Claims

1. A resonator assembly, comprising:

a resonator having a first resonance post coaxially surrounded by a conductive enclosure defining a cavity, said

first resonance post being operable to filter a signal at a first frequency and a second resonance post located within said cavity, said second resonance post being operable to filter a signal at a second frequency.

2. The resonator assembly of claim 1, wherein said first resonance post and said second resonance post upstand from said conductive enclosure.
3. The resonator assembly of claim 1 or 2, wherein said second frequency is greater than said first frequency.
4. The resonator assembly of any preceding claim, wherein harmonics of said first frequency fail to coincide with harmonics of said second frequency.
5. The resonator assembly of any preceding claim, wherein said first resonance post and said second resonance post have matching electrical lengths.
6. The resonator assembly of any preceding claim, wherein said first resonance post is located centrally within said conductive enclosure and said second resonance post is located away from said first resonance post and towards said conductive enclosure.
7. The resonator assembly of any preceding claim, wherein said first resonance post is operable to convey a signal using a first signal feed and said second resonance post is operable to convey a signal using a second signal feed, at least one of said first signal feed and said second signal feed being provided through a base of said conductive enclosure from which a respective one of said first resonance post and said second resonance post upstands.
8. The resonator assembly of any preceding claim, wherein said first resonance post and said second resonance post convey a signal using a common signal feed positioned between said first resonance post and said second resonance post.
9. The resonator assembly of claim 8, wherein said common signal feed extends between a base of said conductive enclosure from which said first resonance post and said second resonance post upstands and a face of said conductive enclosure towards which said first resonance post and said second resonance post upstand.
10. The resonator assembly of any preceding claim, wherein at least one of said first resonance post and said second resonance post is configured to have a variable length.
11. The resonator assembly of any preceding claim, wherein at least one of said first resonance post and said second resonance post comprises a first portion displaceable with respect to a second portion to vary its length.
12. The resonator assembly of claim 11, wherein said first portion is received within said second portion.
13. The resonator assembly of claim 11 or 12, wherein said second portion comprises a post having a cavity extending therethrough for receiving said first portion therewithin.
14. The resonator assembly of any one of claims 11 to 13, wherein said first portion comprises a screw received within a screw thread formed within said cavity, said first portion being protrudable from said second portion to vary its length.
15. The resonator assembly of any preceding claim, comprising a plurality of said resonators adjacently located and having shared portions of said conductive enclosure, and wherein said second resonance post in each resonance filter is located towards said shared portions of said conductive enclosure.

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

1. A resonator assembly, comprising:

a resonator having a first resonance post coaxially surrounded by a conductive enclosure defining a cavity, said first resonance post being operable to filter a signal at a first frequency and a second resonance post located within said cavity, said second resonance post being operable to filter a signal at a second frequency; wherein said first and second resonance posts are configured such that harmonics of said first frequency fail to coincide

with harmonics of said second frequency and a ratio of said first and second frequency are not close to unity allowing said first and second frequency signals to be uncoupled; and said first resonance post is located centrally within said conductive enclosure and said second resonance post is located away from said first resonance post and towards said conductive enclosure.

2. The resonator assembly of claim 1, wherein said first resonance post and said second resonance post upstand from said conductive enclosure.
3. The resonator assembly of claim 1 or 2, wherein said second frequency is greater than said first frequency.
4. The resonator assembly of any preceding claim, wherein said first resonance post and said second resonance post have matching electrical lengths.
5. The resonator assembly of any preceding claim, wherein said first resonance post is operable to convey a signal using a first signal feed and said second resonance post is operable to convey a signal using a second signal feed, at least one of said first signal feed and said second signal feed being provided through a base of said conductive enclosure from which a respective one of said first resonance post and said second resonance post upstands.
6. The resonator assembly of any preceding claim, wherein said first resonance post and said second resonance post convey a signal using a common signal feed positioned between said first resonance post and said second resonance post.
7. The resonator assembly of claim 6, wherein said common signal feed extends between a base of said conductive enclosure from which said first resonance post and said second resonance post upstands and a face of said conductive enclosure towards which said first resonance post and said second resonance post upstand.
8. The resonator assembly of any preceding claim, wherein at least one of said first resonance post and said second resonance post is configured to have a variable length.
9. The resonator assembly of any preceding claim, wherein at least one of said first resonance post and said second resonance post comprises a first portion displaceable with respect to a second portion to vary its length.
10. The resonator assembly of claim 10, wherein said first portion is received within said second portion.
11. The resonator assembly of claim 9 or 10, wherein said second portion comprises a post having a cavity extending therethrough for receiving said first portion therewithin.
12. The resonator assembly of any one of claims 9 to 11, wherein said first portion comprises a screw received within a screw thread formed within said cavity, said first portion being protrudable from said second portion to vary its length.
13. The resonator assembly of any preceding claim, comprising a plurality of said resonators adjacently located and having shared portions of said conductive enclosure, and wherein said second resonance post in each resonance filter is located towards said shared portions of said conductive enclosure.

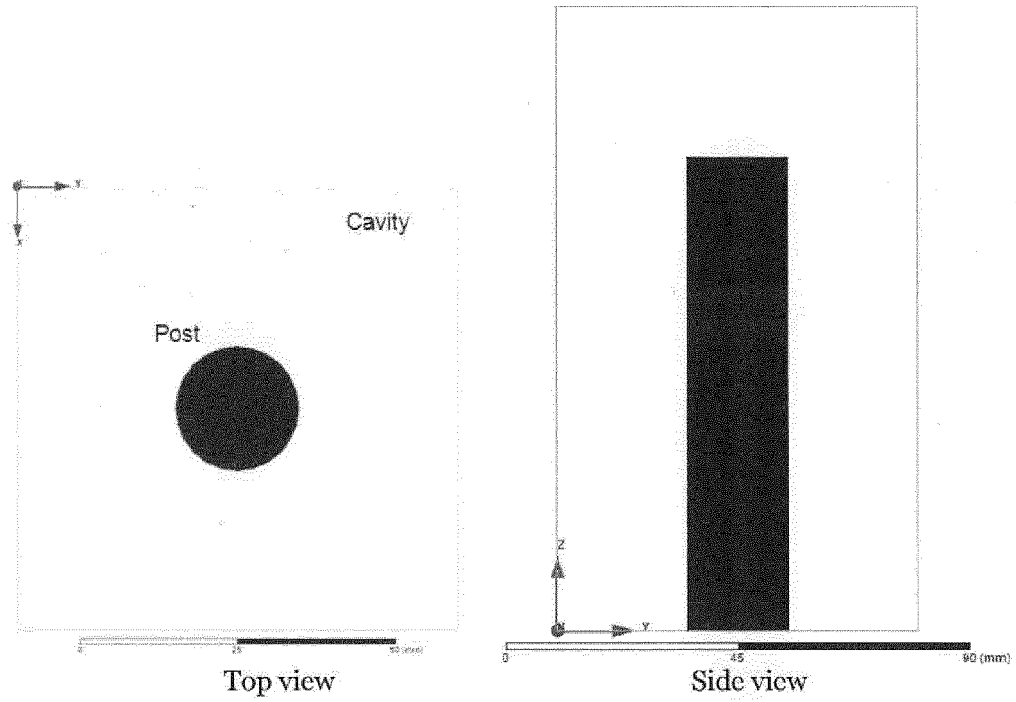


Figure 1: Configuration of conventional combline resonator

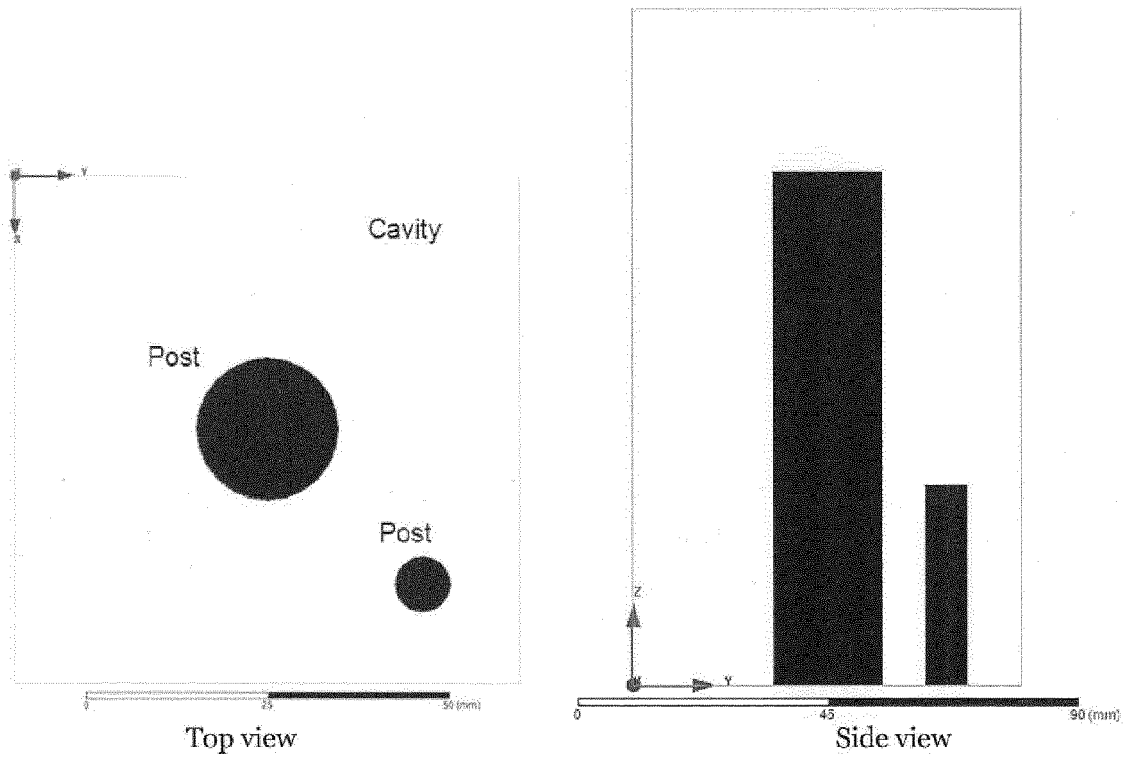
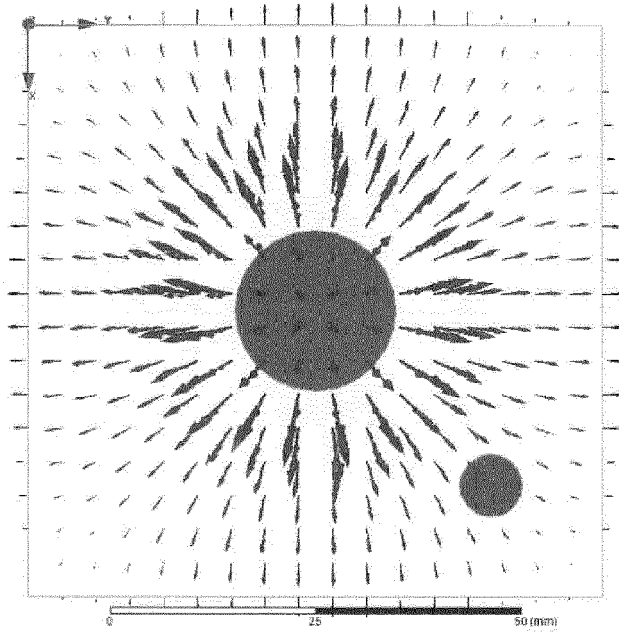
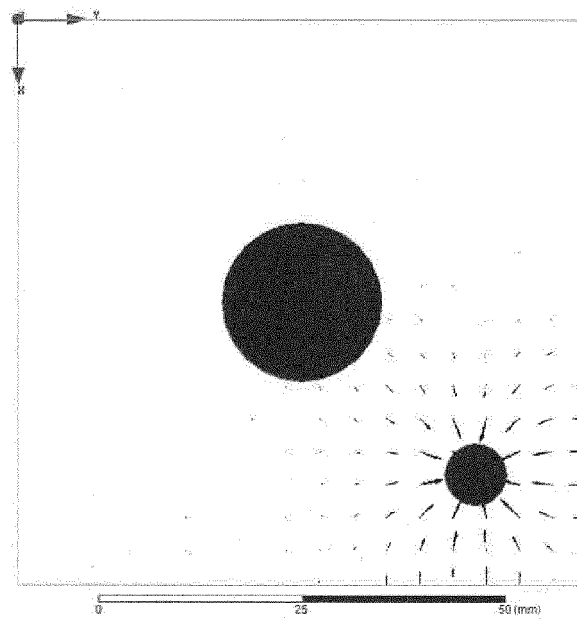


Figure 2: Configuration of proposed dual-frequency combline resonator

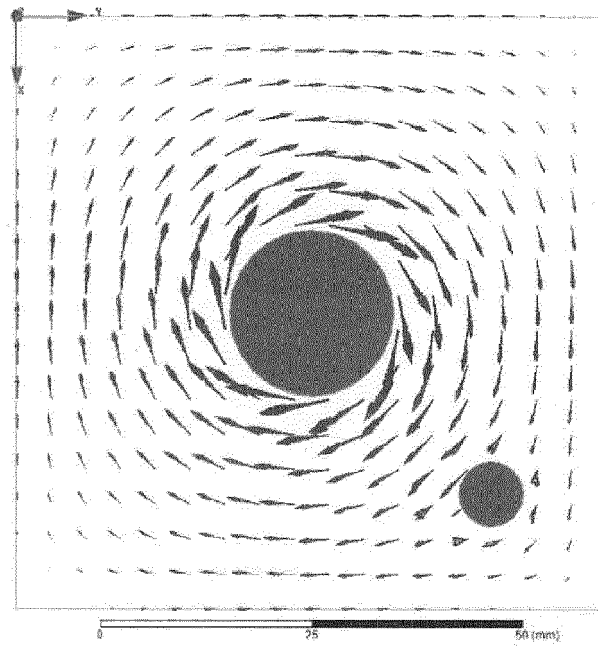


Low frequency

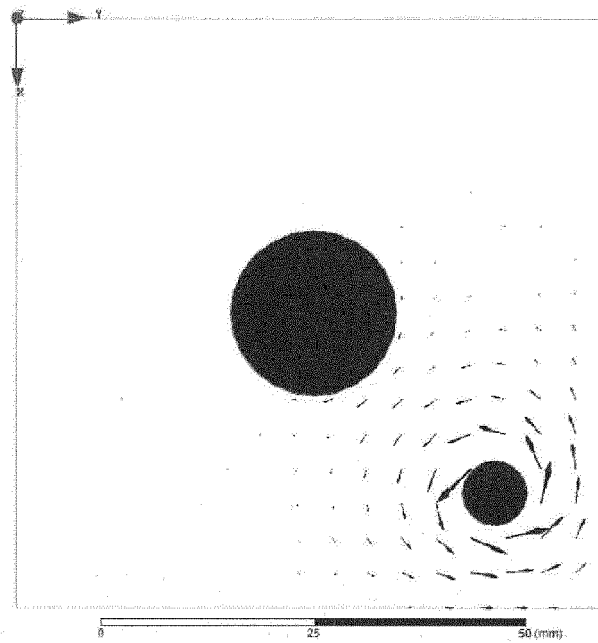


High frequency

Figure 3: Electric field distribution at resonance at the low frequency and Electric field distribution at resonance at the high frequency

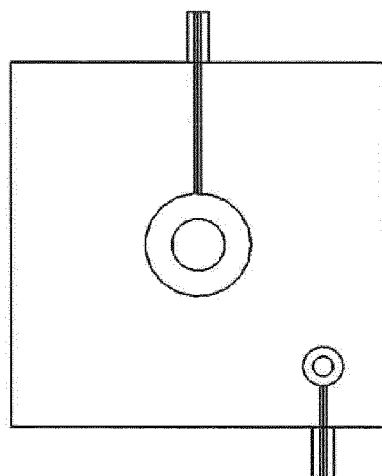


Low Frequency

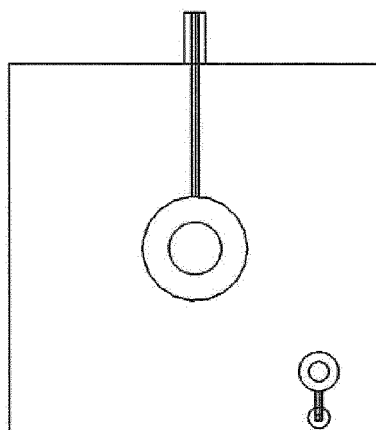


High frequency

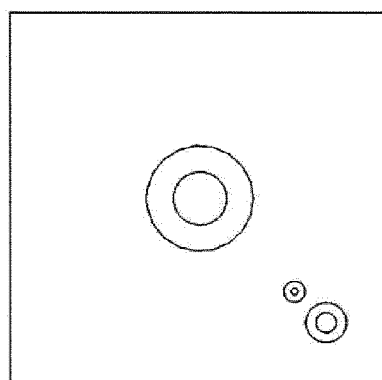
Figure 4: Magnetic field distribution at resonance at the low frequency and Magnetic field distribution at resonance at the high frequency



a)



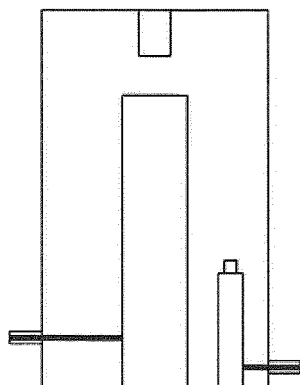
b)



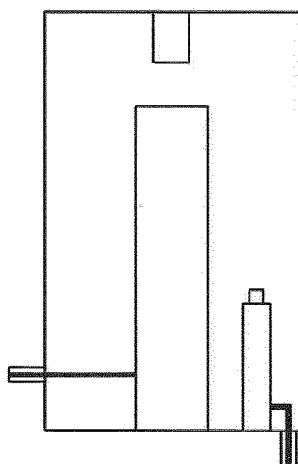
c)

Figure 5: Feeding pin configurations (top view)

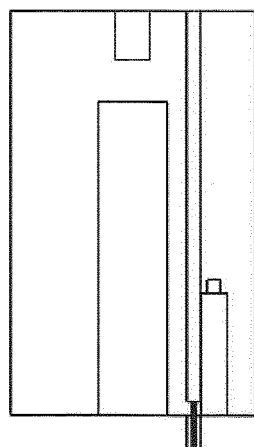
a) would be suitable for an inline configuration, b) would suit a folded configuration, c) for dual-band filters. Combination of c and either b or a can be suitable for a duplexer configuration



a)



b)



c)

Figure 6: Feeding pin configurations (side view).
a) would be suitable for an inline configuration, b) would suit a folded configuration, c) for dual-
band filters. Combination of c and either b or a can be suitable for a duplexer configuration

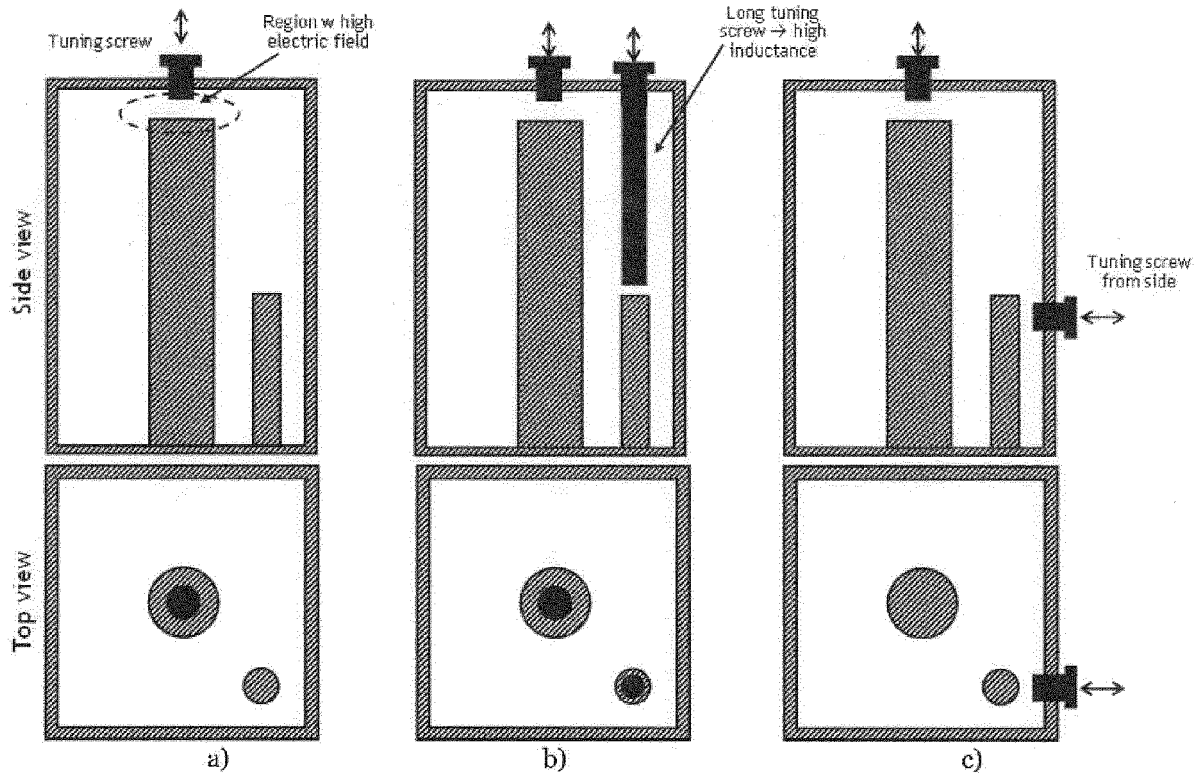


Figure 7: tuning mechanisms for dual-resonance structures:

- a) shows the tuning screw placement and function for the lower resonance resonator
- b) shows the tuning screw placement from top for the higher resonance filter, depicting the difficulty of a long screw, mechanical unstable and leading to increased losses and possibly complete de-tuning of the higher resonance
- c) shows a possible tuning solution from the side of the resonator

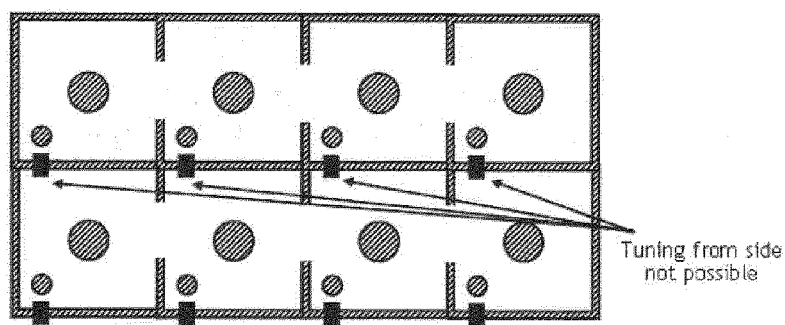


Figure 8: shows the problem of using the tuning screw from the side; in many configurations this will not be possible.

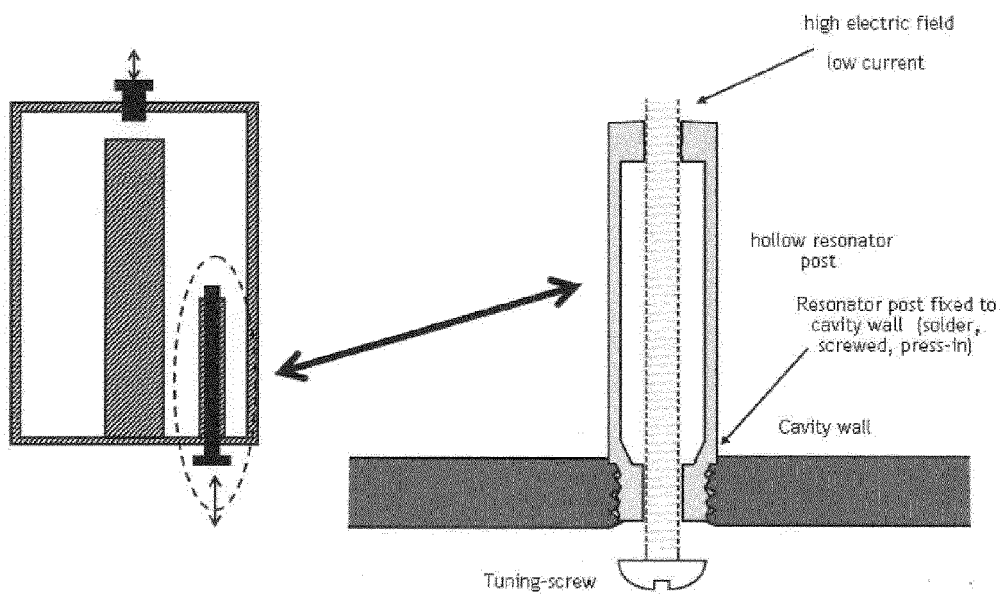
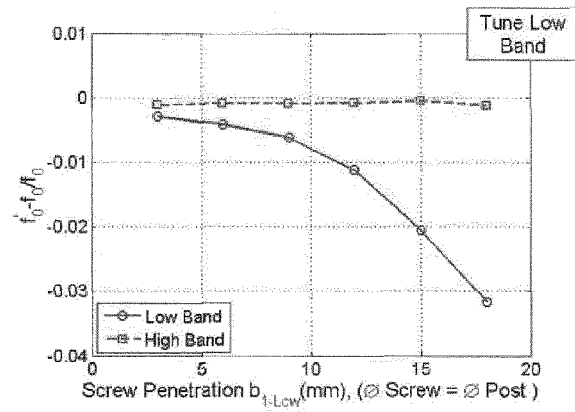
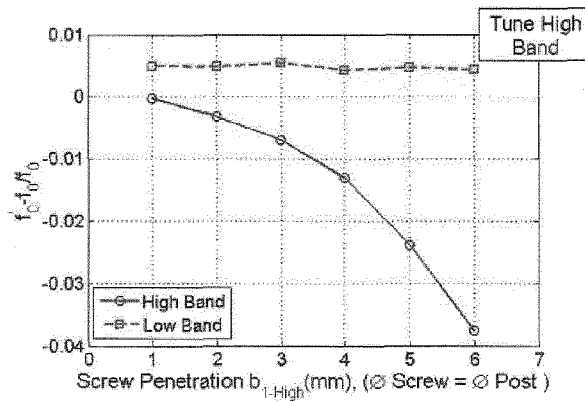


Figure 9: a tuning screw which protrudes through the resonator post itself.



a)



b)

Figure 10. a) Resonant frequency normalized to resonant frequency with no screw as a function of low-band screw penetration (mm) for low-band (solid line) and for high-band (dashed line). b) Resonant frequency normalized to resonant frequency with no screw as a function of high-band screw penetration (mm) for high-band (solid line) and for low-band (dashed line).



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