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GB 2499725 B

Figure 1

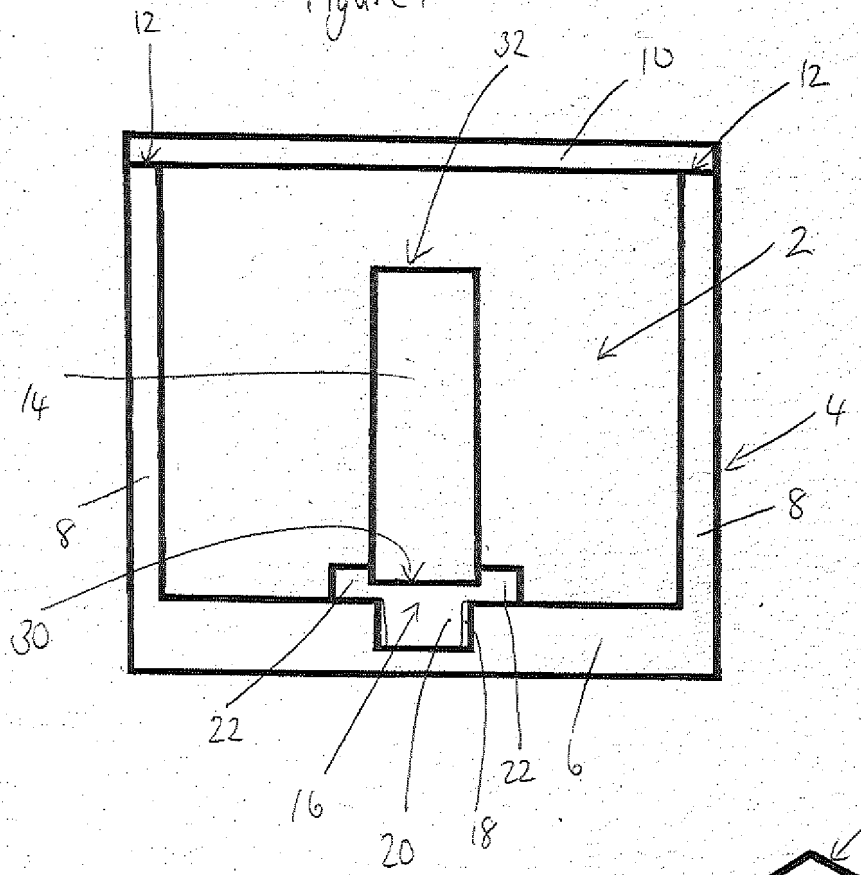
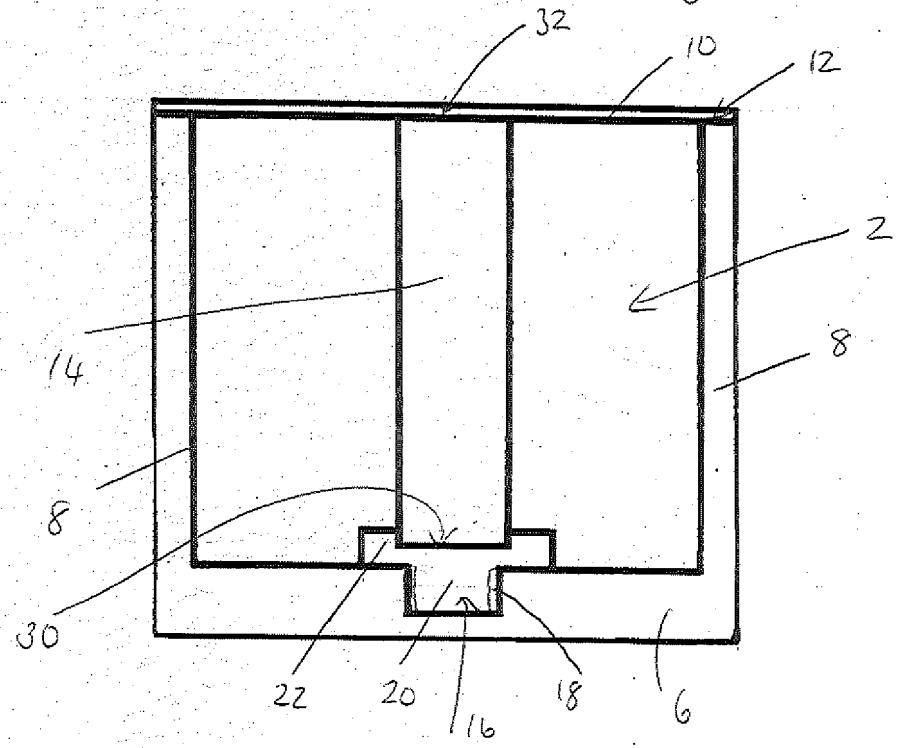


Figure 2



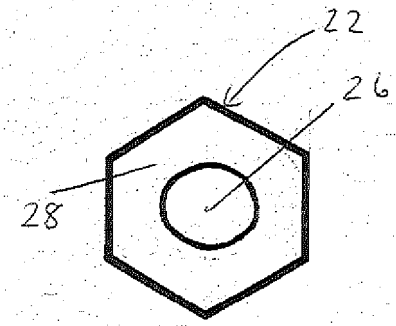


Fig. 3a

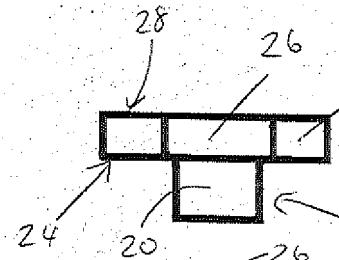


Fig. 3b

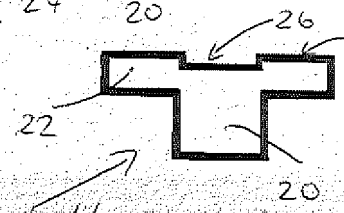


Fig. 3c

Filter Apparatus and Method of Manufacture Thereof

This invention relates to filter apparatus and to a method of manufacture thereof.

A filter apparatus is typically used in a telecommunication system to compensate for disturbances, such as interference, that may affect one or more transmission signals being sent and/or received by the telecommunication system. The filter apparatus is designed to remove unwanted components from the transmit and/or receive signals and/or enhance the desired transmit and/or receive signals.

Telecommunication systems, such as broadcast radio, television, wireless communication systems (i.e. mobile phones, Wi-Fi (RTM) etc) and/or the like which transmit and/or receive signals in the medium to high frequency ranges (i.e. in the megahertz and gigahertz frequency ranges) typically use radio frequency (RF) and microwave filter assemblies in order to filter their transmit and/or receive signals. An example of conventional RF or microwave filter apparatus typically includes a conductive housing defining one or more resonant cavities therein with one or more resonators located in each cavity. A resonator is an electronic component that exhibits resonance for a narrow range of frequencies. Two or more resonators within the filter are typically electromagnetically coupled together to provide the filter with a required set of performance characteristics.

The performance of filter apparatus can be measured by its Quality or Q factor. The Q factor is proportional to the energy stored to the power lost in the resonator. The Q factor is also a measure of a resonator's bandwidth relative to its centre

frequency. A filter consisting of high Q resonators will have a relatively sharp transition from passband to stop band and have relatively small power loss in the passband. The Q factor of filter apparatus typically increases as the size of the cavity in which the resonator is located also increases. However, it is normally desirable to have the smallest filter size possible with the highest Q factor, so as to reduce costs associated with manufacturing the filter apparatus and to reduce the size of the apparatus required to be operated, transported and/or stored. This is particularly the case when the filter apparatus is to be installed, either directly or as an integral part of another device such as a tower mounted amplifier (TMA) or remote radio head (RRH), on a mast or tower.

Filter assemblies for the telecommunications industry use a range of resonator technologies. A common choice is the use of co-axial or combline resonators, which comprise a central metal conductor within a conductive cavity. Combline resonators are relatively inexpensive to produce and provide a reasonable Q factor for a given volume. An alternative choice is the use of dielectric resonators. Dielectric resonators are made from ceramic material and are also known as ceramic resonators. Such resonators come in a range of different shapes and sizes which influence both the frequency and mode of the electromagnetic resonance. A common choice for a dielectric resonator has been a ceramic puck that resonates in the TE01δ mode. A TE01δ dielectric resonator typically has a Q that is significantly higher than a combline resonator but they are significantly more expensive and, in many cases, are also much larger in size.

Another class of dielectric resonators are so called dielectric rod resonators. Such resonators consist of a rod of ceramic material that may be in contact with a conductive cavity at both ends of the rod, one end of the rod or neither end of the rod. The

resonant mode of the dielectric rod depends on how many ends are in contact with the conductive cavity. Dielectric resonators offer a Q that, depending on the size of the resonator, can range from that of a combline resonator to that of a TE01δ puck. The size of the resonator impacts the Q but the dielectric rod can offer a Q per unit volume performance far superior to that of both a combline resonator and other dielectric resonators. Furthermore, the cost of the dielectric rods is low compared to other dielectric resonators. For the above reasons, dielectric rod resonators are attractive for use in telecommunication products.

It is important that good electrical contact is made between the resonator rod end(s) and the conductive wall of the resonator cavity to which the rod is attached to in use. The electrical contact is often conventionally achieved by soldering the rod end to the cavity wall. However, a problem with such filters is that the electrical contact formed between the rod and the cavity may not be sufficient to provide a reproducible and substantially similar resonant frequency across a plurality of resonators within a filter. In addition, the filter may operate over a range of temperatures in use and as the resonator rod and the cavity are likely to have different coefficients of expansion, the electrical contact formed between the rod and the cavity wall or lid can be affected, particularly in the case when the resonator rod is attached at both ends to the cavity. The different rates of expansion can lead to cracked solder joints and complete failure of the filter. Thus, it is desirable that the resonator rod is arranged in the filter cavity in such a manner so as to be able to compensate for mechanical tolerances when the filter is assembled and in use.

Telecommunication filters are often integrated with other components and/or situated outdoors where they are exposed to harsh environmental conditions, including rain, ice and salt

spray. It is therefore often the case that the outer surface of the base of the cavity is not accessible as it is either attached to other components or forms an outer sealed surface of the filter. It is therefore desirable that the resonator rod is arranged in the cavity in such a manner that access to the outer surface of the cavity base is not required.

Filters for the telecommunications market are manufactured in large volume. However, due to the construction and sensitivity to manufacturing tolerances, the filter assembly process requires a substantial amount of manual labour. It is therefore critical that the resonator rod is assembled in the cavity in a straightforward manner that lends itself to repeatable and efficient manufacture. Furthermore, the cost of the filter is further reduced if the part count is minimised.

In an attempt to overcome the abovementioned problems, Yamakawa et al (US2005030131) discloses applying a metal layer to each end of the resonator rod, recessing a base end of the resonator rod into the cavity wall and applying electrical contact pressure to the top end of the resonator rod using a leaf spring. Problems with this arrangement are that the electrical contact between the leaf spring and the top of the resonator rod is likely to be poor, it requires access to both ends of the filter cavity in order to secure the rod in position within the cavity, thereby increasing the cost of assembly and manufacture, and the filter lid for the cavity including the leaf spring is likely to be expensive and difficult to manufacture.

US20110128097 discloses a dielectric resonator that is inserted into a guide groove in the base of the filter housing. A metal plate is interposed between the cover and the housing and a dielectric fixing screw is engaged with the cover. Although the provision of the fixing screw allows the resonator to be adjusted

for manufacturing tolerances during assembly, once the fixing screw is assembled in place, the resonator is still not able to accommodate changes in the size of the resonator as a result of temperature change of the filter in use.

WO2009/096836 discloses a filter assembly including a dielectric rod. The base end of the dielectric rod is detachably attached to the base of the filter cavity. The filter cavity has a filter cover or lid and a conductive element is then placed centrally of the lid between the dielectric rod and the filter cover or lid and soldered in position to the rod. The conductive element can be "slightly elastic" to compensate for mechanical tolerances in the filter chassis and/or resonator rod during use. The soldering of the conductive element to the resonator rod takes place before the resonator rod is located in the filter chassis. A problem with this arrangement is that the rod has to be attached to the conductive element, which then has to be attached to the filter cover or lid, which in turn has to be attached to the filter chassis. A number of different components and fastening means are required to form a secure fit between the resonator, the conductive element, the lid and the chassis. It therefore requires a number of components and a relatively complex assembly procedure.

It is an aim of the present invention to overcome the abovementioned problems by providing an improved dielectric rod for filter apparatus.

It is a further aim of the present invention to provide a method of assembling a dielectric rod for filter apparatus.

It is a yet further aim of the present invention to provide filter apparatus including at least one dielectric rod.

It is a yet further aim of the present invention to provide a method of assembling filter apparatus including at least one dielectric rod.

It is a yet further aim of the present invention to provide a telecommunication system including filter apparatus.

According to a first aspect of the present invention there is provided filter apparatus according to claim 1.

Preferably each cavity is defined by a base wall and one or more side walls. An opening is preferably defined in the cavity opposite to the base wall. Preferably the wall of the cavity to which the one or more dielectric rods are attached to or detachably attached to is a base of the cavity of the filter housing.

Preferably the securing means are arranged such that the dielectric rod can be fitted in the cavity to the securing means via or through the opening of the cavity. Preferably the cavity opening is adjacent a top of the cavity opposite to the base wall. Access through the base wall of the cavity is typically not required. This increases the ease of assembling the dielectric rod(s) in the filter housing in use.

The securing means can include any or any combination of friction fit, one or more screws, screw threads, nuts and bolts, clips, welding, soldering, adhesive, inter-engaging members and/or the like.

In a preferred embodiment the second end of the dielectric rod is soldered to the securing means and the securing means are then attached or detachably attached to a wall of the filter housing cavity.

Preferably the securing means include or comprise substantially electrically conductive material. For example, the securing means can be formed from substantially electrically conductive material or can be provided with at least an external coating of substantially electrically conductive material thereon. Further preferably the substantially electrically conductive material is metal.

In one embodiment the securing means includes a body portion with an outwardly extending flange portion or protrusion means to allow a fitting tool to grip the same in use. The outwardly extending flange portion or protrusion means typically sits above or on the wall of the cavity it is to be fitted to in use with a remaining portion of the securing means body portion engaging in the filter housing cavity wall. This increases the ease by which the securing means can be attached, removed from or detachably attached to the wall of the filter housing cavity in use. Preferably the outwardly extending flange portions is provided at or adjacent a top of the securing means.

Preferably at least one recess, slot, groove, aperture and/or the is like is defined in a cavity wall of the filter housing, and preferably a base wall of the cavity, to allow an end, base or the second end of the dielectric rod and/or securing means to be located therein in use. Preferably an end of the securing means opposite the end of the securing means with the flange portion or protrusion means is located in the at least one recess, slot, groove, aperture of the filter housing cavity wall.

In one embodiment the securing means are arranged such that once attached to the filter housing cavity wall, removal of the securing means is substantially prevented. For example, the securing means could include uni-directional movement means,

such as for example one or more barbs, teeth and/or the like which prevent removal of the securing means from a recess, slot, groove and/or aperture in which it is located in use.

Preferably the uni-directional means are provided towards a base of the securing means.

In one embodiment the securing means includes location means for locating an end or the second end of the dielectric rod therein in use.

Preferably the location means are provided at or adjacent a top of the securing means.

In one embodiment the location means of the securing means can include any or any combination of one or more recesses, indents, apertures, slots, grooves and/or the like. Preferably said one or more location means, recesses, indents, apertures slots or grooves are defined on an upper or top surface thereof for the location of the end or second end of the dielectric rod therein in use.

In one embodiment the lid or cover is formed so as to have sufficient flexibility or elasticity to compensate for mechanical tolerances during use of the dielectric rod and/or filter apparatus. Preferably the lid or cover is of such a size, shape and/or dimensions so as to cover substantially at least one entire cavity of the filter housing or opening of said filter housing cavity when fitted.

Thus, in one embodiment of the present invention the conductive element provides a cover or lid for a filter housing cavity that is sufficiently flexible to take up or compensate for mechanical tolerances during use of the dielectric rod and/or

filter housing whilst covering substantially the entire cavity of the filter housing in which the dielectric rod or rods are located. As such, only a single lid or cover component is required for a filter housing cavity or cavities, thereby reducing the cost, time and complexity of assembling the dielectric rod in the filter housing compared to the dielectric rod assemblies of the prior art. This is also in contrast to some conventional filter assemblies that use a rigid aluminium plate to cover the cavities of the filter and which do not allow mechanical tolerances to be taken up by the resonator rod during use. The provision of the dielectric rod connected to or in abutment with the relatively flexible conductive element that forms a lid or cover for the cavity surprisingly does not substantially change the resonate frequency of the rod. The Q factor of the rod and/or filter also remains high.

Preferably the one or more cavities of the filter housing are electrically conductive cavities in that one or more surfaces of the filter housing walls defining the cavity have an outer electrically conductive layer associated with the same. The one or more dielectric rods are typically located in the electrically conductive cavities in the filter housing.

In one embodiment the dielectric rod has a substantially electrical conductive layer or layers or is metallised at said first end and/or said second end. For example, one or more metallic or electrically conductive layers are provided on or associated with said first and/or said second ends, and preferably the outer surface of said first and/or said second ends.

In one embodiment attachment means or an attachment mechanism is provided on or associated with the lid or cover and/or filter housing to allow attachment of the lid or cover to a part of the filter housing in use.

Preferably the lid or cover is attached to or attachable to one or more side walls of the filter housing defining the one or more cavities within the filter housing using the attachment means. Further preferably the lid or cover is attached to or attachable to an upper free edge or edges of one or more side walls of the filter housing.

The attachment means can include any or any combination of soldering, one or more screws, nuts and bolts, clips, adhesive, inter-engaging members and/or the like.

The lid or cover is formed from printed circuit board (PCB) material. The PCB material can include one or more electrically conductive layers provided or etched thereon, such as for example one or more copper conducting layers. Alternatively, or in addition, the material can include one or more electrically insulating layers. Two or more of the conductive and/or insulating layers can be laminated together. The one or more insulating layers can be formed from any or any combination of resin, epoxy resin, Teflon®, FR-4, CEM-1 or CEM-2 (cotton paper and epoxy), CEM-3 (non-woven glass and epoxy), CEM-4 or CEM-5 (woven glass and epoxy), FR-2 (phenolic paper and epoxy), FR-3 (cotton paper and epoxy), FR-5 (woven glass and epoxy), FR-6 (matte glass and polyester), G-10 (woven glass and epoxy) and/or the like.

In a preferred embodiment the surface of the printed circuit board material facing inwardly of the filter housing cavity has one or more conducting layers provided or etched thereon.

In one embodiment the filter housing includes a plurality of cavities. One or more of the cavities can include at least one dielectric rod. A single lid or cover can be provided over or

covers substantially each or a single cavity, over two or more of the cavities or over all the cavities, as required. Thus, in one embodiment a single lid or cover is provided over all the cavities of the filter apparatus to which one or more dielectric rods are attached.

In one embodiment each cavity includes two or more dielectric rods. Preferably the two or more dielectric rods are attached to one or more of the cavity walls and the lid or cover in the same manner as each other.

In one embodiment one or more electronic components, such as electronic circuitry components are provided on a surface of said printed circuit board material. Preferably the one or more electronic components are provided on an upper or outer surface of the said printed circuit board material (For example, the one or more electronic components can be provided on the surface of the printed circuit board material facing outwardly of the cavity or on the surface of the PCB material opposite to the surface to which the dielectric rod is attached).

Preferably the lid or cover has at least one aperture defined therein to allow solder to be inserted therethrough during assembly of the dielectric rod with the lid or cover and/or filter housing. The position of the aperture is typically arranged to be adjacent to and/or aligned with the position of the dielectric rod in use. As such, additional solder inserted through the at least one aperture further increases the electrical contact between the dielectric rod and the lid or cover in use.

It will be appreciated that the term dielectric rod also covers a ceramic resonator rod.

The ceramic rod can be formed from any or any combination of Titanium oxide, Barium Strontium Titanate, Zironium Titanate, Magnesium Titanate, Calcium Titanate and/or the like. Preferably the ceramic material(s) chosen to form the rod will have a relatively high dielectric constant and low loss, hence provide a relatively high material Q factor and therefore be suitable for use in high performance microwave filters in one example.

One or more additives can be incorporated into the ceramic rod material in order to control and/or improve frequency stability with temperature. For example, the one or more additives can include one or more "rare earth" materials.

The dielectric or ceramic rod is typically an elongate rod that is located within a cavity of a filter chassis or housing in use, and preferably such that the longitudinal axis of the rod is arranged between a top and base of the filter housing cavity. Preferably the longitudinal axis of the rod is substantially parallel to a side wall of the cavity.

According to one embodiment of the present invention there is provided a dielectric rod for a cavity of a filter housing, the dielectric rod having at least a first end and a second end, the second end attachable to a wall of the filter housing using securing means.

According to one embodiment of the present invention there is provided a method of assembling a dielectric rod for a cavity of a filter housing, said method including the step of attaching the dielectric rod to a wall of the cavity using the securing means.

Thus, it will be appreciated that the present invention can subsist in:

a) where the dielectric resonator rod is attached to both a base of the cavity using securing means and a top, cover, lid or conductive element of the cavity.

According to one aspect of the present invention there is provided a method of assembling filter apparatus according to claim 22.

According to a yet further embodiment of the present invention there is provided a telecommunication system including filter apparatus.

According to one embodiment of the present invention there is provided filter apparatus, said filter apparatus including a housing having one or more cavities defined therein with one or more dielectric rods located therein, each of said cavities having an opening thereto, and wherein said filter apparatus further includes a substantially electrically conductive element to which an end of said one or more dielectric rods are attached to and/or are in contact with, said conductive element formed so as to have sufficient flexibility or elasticity to compensate for mechanical tolerances during use of the dielectric rod and/or filter apparatus, and wherein the conductive element is of such a size, shape and/or dimensions so as to cover substantially at least one entire cavity or opening of said cavity when fitted, and wherein a further end of the said one or more dielectric rods is attached to a wall of the filter housing cavity using securing means

Embodiments will now be described with reference to the following figures, wherein:

Figure 1 is a side view of a cavity of a filter assembly with a dielectric rod attached to a base of a filter housing cavity only

using securing means which does not form part of the present invention;

Figure 2 is a side view of a cavity of a filter assembly with the dielectric rod attached to both a base of a filter housing cavity using securing means and a lid or cover of the filter housing cavity according to the present invention; and

Figures 3a-3c show a top plan view, side view and end view of securing means for an end of the dielectric rod in the embodiments shown in figures 1 and 2.

Referring firstly to figure 1, there is illustrated a cavity 2 of a filter housing 4. The filter housing is typically of a type for use as part of a telecommunications system. Although only a single cavity is shown in the illustrations for the purposes of clarity, it will be appreciated by persons skilled in the art that the filter housing 4 can include any number of cavities as required.

The cavity 2 has a base wall 6 and side walls 8. The cavity 2 has an opening to the cavity adjacent a top thereof which is covered substantially entirely by an electrically conductive element in the form of a lid 10. The lid can be attached to upper free ends 12 of the side walls 8 via any suitable attachment means. In one example the attachment means are screws for location in complementary shaped recesses in the free ends 12 of side walls 8.

The lid 10 can be formed from substantially rigid material, such as for example an aluminium metal plate. A surface of the material facing inwardly of the cavity is typically formed from or provided with an electrically conductive layer or material. The lid 10 can be formed from a substantially flexible material and in one example is circuit board material. The lid material in either

aspect is typically formed from electrically conductive material or includes one or more electrically conductive layers thereon.

In figure 1, a first end 32 of a ceramic dielectric resonator rod 14 is typically arranged in free space within the cavity 2 and is therefore a spaced distance apart from any of the side walls of the filter housing. A second end 30 of the rod 14 is attached to base 6 of cavity 2 via securing means in the form of a threaded screw 16. More particularly, a recess 18 is defined in base 6 which is of only slightly larger dimensions than the dimensions of a threaded portion 20 of threaded screw 16. Threads (not shown) are provided on the walls of the recess 18 which are complementary to the threaded portion 20 of screw 16, thereby allowing a tight and secure fit when said threaded portion 20 is moved into engagement with the recess threads.

It will be appreciated that the securing means could be provided in any suitable form to allow attachment or detachable attachment of the same with the base of the cavity.

Threaded screw 16 has a head portion 22 at a top end 24 thereof which is of larger dimensions than threaded portion 20, as shown in figures 3a-3c, thereby providing a flange or protruding portion at the top end 24 that extends beyond the external side walls of threaded portion 20. When fitted, a base end of the screw 16 is located in recess 18 and the underside protruding surface of the head portion 22 engages with the base wall of the cavity around recess 18. The head portion 22 therefore sits above the base wall of the cavity and can easily be gripped by a fitting tool being used within the cavity above base 6 of the cavity. As such, the screw 16 can be attached to the base 6 through a top opening of the filter assembly and access via the base of the filter assembly is not required. The threaded screw portion 20 is provided at a base end of the securing means.

A recess 26 is defined in a top surface 28 of head portion 22 of screw 16. The dimensions of recess 26 are only slightly larger than the dimensions of a second end 30 of dielectric rod 14, thereby allowing for the location of second end 30 in said recess 26 in use. In one example, the second end 30 is metalised and soldered into position in recess 26.

Figure 2 refers to an embodiment of the present invention wherein rod 14 is attached to lid 10 of the cavity 2. The attachment of rod 14 to the base 6 of the cavity is similar to the arrangement described in figure 1. The lid 10 in this embodiment is constructed from a substantially flexible lid material of printed circuit board material

First end 32 is metalised and attached to lid 10 via soldering to form a good electrical contact. Due to the flexibility of the lid 10, rod 14 can take up or compensate for mechanical tolerances of the rod and/or filter assembly caused by contraction and/or expansion of the same due to temperature changes of the filter and/or rod in use.

It will be appreciated that the end(s) of the rod can be metalised and soldered in one embodiment. In the embodiment shown in figure 2, the end(s) of the rod, whether metalised or non-metalised, could simply abut or press against the flexible lid 10.

An aperture (not shown) can be defined through lid 10 in a position substantially centrally of the attachment point for end 32 of rod 14. Once the lid 10 is fixed in position on the top free ends 12 of the side walls 8, additional solder can be located through the aperture to further increase the electrical contact between first end 32 of rod 14 and the lid 10.

In one embodiment a channel or aperture can be defined in or through said rod. The channel or aperture is typically arranged such that the longitudinal axis of the channel or aperture is substantially parallel or coaxial with the longitudinal axis of the rod. The channel or aperture could run substantially the entire length of the rod or could be provided in a portion of the rod only.

In one embodiment the cavity, lid and/or rod can be provided with or have a tuning mechanism associated therewith. For example, a tuning screw could be provided in the lid of the cavity to allowing tuning of the rod. The tuning screw can be used to tune the resonant frequency of a dielectric rod and/or the electromagnetic coupling between two or more adjacent dielectric rods.

Claims

1. Filter apparatus, said filter apparatus including a housing having one or more cavities defined therein with one or more dielectric rods located therein, the one or more dielectric rods have at least a first end and a second end, the first end of the one or more dielectric rods connected to or in abutment with a lid or cover formed from printed circuit board material which is on or associated with the filter housing cavities, and wherein the second end of said one or more dielectric rods is attached to or detachably attached to a wall of the cavities of the filter housing via securing means.

2. Filter apparatus according to claim 1 wherein the securing means includes any or any combination of friction fit, soldering, adhesive, welding, one or more screws, screw threads, nuts and bolts or inter-engaging members.

3. Filter apparatus according to claim 1 wherein the securing means includes a body portion with an outwardly extending flange portion or protrusion means.

4. Filter apparatus according to claim 3 wherein the outwardly extending flange portion or protrusion means are provided at or adjacent a top of the securing means and a base of the securing means is used for securing the securing means to the wall of the filter housing cavities.

5. Filter apparatus according to claim 1 wherein the securing means includes one or more uni-directional movement means, barbs or teeth.

6. Filter apparatus according to claim 1 wherein the securing means includes location means for the location of an end of the dielectric rod in use.

7. Filter apparatus according to claim 6 wherein the location means are provided at or adjacent a top of the securing means.

8. Filter apparatus according to claim 6 wherein the location means includes any or any combination of one or more recesses, indents, apertures, slots, or grooves.

9. Filter apparatus according to claim 1 wherein at least one recess, slot, groove or aperture is defined in a wall of the filter housing cavities to allow an end of the securing means to be located therein in use.

10. Filter apparatus according to claims 1 or 9 wherein the wall of the filter housing cavities is a base wall.

11. Filter apparatus according to claim 1 wherein the lid or cover to which said one or more dielectric rods are attached to and/or are in contact with is formed from a substantially flexible material to compensate for mechanical tolerances during use of the dielectric rod and/or filter apparatus, and wherein the lid or cover is of such a size, shape and/or dimensions so as to cover substantially at least one entire cavity or opening of said cavity when fitted.

12. Filter apparatus according to claim 1 wherein the lid or cover is a single component.

13. Filter apparatus according to claim 1 wherein the dielectric rod has one or more electrically conductive layers and/or is metallised at the first end and/or the second end.

14. Filter apparatus according to claim 1 wherein attachment means are provided on or associated with the lid or cover to allow attachment of the lid or cover to the filter housing.

15. Filter apparatus according to claim 14 wherein the attachment means includes any or any combination of soldering, adhesive, one or more screws, nuts and bolts, inter-engaging members or clips.

16. Filter apparatus according to claim 1 wherein the printed circuit board material from which the lid or cover is formed includes one or more electrically conductive layers provided or etched thereon and/or one or more electrically insulating layers.

17. Filter apparatus according to claim 16 wherein the one or more electrically conductive layers include one or more copper conducting layers.

18. Filter apparatus according to claim 16 wherein the one or more insulating layers is formed from any or any combination of resin, epoxy resin, Teflon®, FR-4, CEM-1 or CEM-2 (cotton paper and epoxy), CEM-3 (non-woven glass and epoxy), CEM-4 or CEM-5 (woven glass and epoxy), FR-2 (phenolic paper and epoxy), FR-3 (cotton paper and epoxy), FR-5 (woven glass and epoxy), FR-6

(matte glass and polyester), or G-10 (woven glass and epoxy).

19. Filter apparatus according to claim 1 wherein the filter housing includes two or more cavities and the lid or cover is of such a size, shape and/or dimensions to substantially cover two or more of said cavities or all the cavities of the filter housing.

20. Filter apparatus according to claim 1 wherein each cavity of the filter housing includes two or more dielectric rods.

21. Filter apparatus according to claim 1 wherein a tuning mechanism is provided with or associated with the cavity, dielectric rod, filter housing and/or lid or cover.

22. A method of assembling filter apparatus, said filter apparatus including a housing having one or more cavities defined therein with one or more dielectric rods located therein said method including the step of connecting or abutting a first end of the one or more dielectric rods to a lid or cover on or associated with the filter housing cavities, and attaching a second end of the one or more dielectric rods to a wall of the cavity of the filter housing via securing means, the lid or cover formed from printed circuit board material.