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

(54) Cavity resonator

(57) A resonator comprises a substrate and a body mounted on the substrate. The arrangement of the body and the substrate defines a resonant cavity. The resonator further comprises a stub which extends into the resonant cavity. The resonant cavity has a capacitance predominantly defined by a capacitance gap between the stub and a surface of the resonant cavity. The resonator further comprises an alignment error reducing structure operable to prevent more than one component mounting induced variation in the capacitance gap.

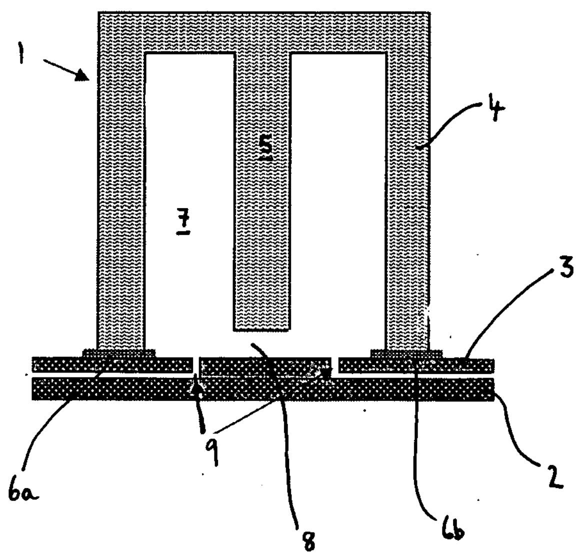

Figure 1

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a cavity resonator and a method of providing a cavity resonator.

BACKGROUND

[0002] Wireless telecommunications systems operating on radio frequencies are known. In those systems, radio coverage is provided to user equipment, for example, mobile telephones, in regions of geographical area. A base station is located in each geographical area to provide the required radio coverage. User equipment in the geographical area served by a base station receives information and data from the base station and transmits data and information to the base station. A base station will typically have a radio frequency front-end high power filtering and duplexing device.

[0003] There is a requirement for high overall base station power efficiency. Furthermore, regulatory bodies demand strict compliance with rules relating to the power spectrum of the transmitted signal. As a result, it is required that such filtering devices meet stringent specifications regarding their transfer function. Examples of those specifications include: requirements for minimal in-band insertion loss, maximal out-of-band rejection and a high close-to-band selectivity. This has resulted in filtering devices that are bulky in volume and expensive to fabricate, and often filtering devices meeting the stringent specifications are typically required to be constructed with high mechanical accuracy.

[0004] It is envisaged that future wireless telecommunication systems will be operable to support higher data rates and heavier traffic and that these future cellular networks will be formed from a series of much smaller cells supported by more base stations. As a result, each base station will typically require a smaller radiation power. These future networks may employ base stations composed of several modular radio antenna each radiating at a medium power level per element (for example, via an active antenna array).

[0005] It is believed that filtering devices for such future systems may be subject to less stringent requirements. There is thus a requirement for filtering technologies which may offer slightly reduced performance but can offer other advantageous features, such as reduced size, reduced fabrication cost, and potential improvement in integratability with other radio front end devices.

[0006] Surface mounted cavity filters are known. Such surface mounted filters can be constructed from multiple re-entrant resonator cavities, also known as "co-axial resonators" mounted directly on printed circuit boards.

[0007] It is desired to provide an improved form of surface mounted re-entrant resonator for use in a surface mounted cavity filter.

SUMMARY

[0008] Accordingly, a first aspect provides a resonator comprising:

a substrate;
a body mounted on the substrate, the arrangement of the body and the substrate defining a resonant cavity;
a stub which extends into the resonant cavity;
the resonant cavity having a capacitance predominantly defined by a capacitance gap between the stub and a surface of the resonant cavity; and
an alignment error reducing structure operable to prevent more than one component mounting induced variation in the capacitance gap.

[0009] It is known to form re-entrant cavity resonator on a PCB. An example is shown in cross-section in Figure 7. Typically, a cavity is formed from two major components: an external body 100 and an internal rostrum 110 (also known as a "stub"). Each of those parts is soldered, via soldering layers 120, to an upper metal plated surface 130 of a PCB 140. In this manner, the metallic surface of the PCB becomes part of the resonator and forms part of a cavity wall. The external body 100 and the metallic surface 130 of the PCB together define a cavity. The internal rostrum 110 provides a stub (in classical cavity resonator terms) within the cavity.

[0010] The electromagnetic resonance of co-axial cavity resonators depends upon the exact dimensions of the cavities and a capacitive gap 150 between the stub and the walls of the cavity. More particularly, a total effective electrical length of the walls of the cavity act to define the total inductance of such a cavity. The dimensions of the capacitive gap 150 between the re-entrant stub and the wall of cavity contribute and dominantly define the capacitance of such a resonator.

[0011] The soldering layers 120a, 120b which attach the two major components of the resonator to the printed circuit boards are conductive and become part of the resonator. As a result, the soldering layers have a direct impact on the resulting resonance of the cavity. If thick, the soldering layers increase the total electrical length of the walls of the cavity and therefore the total inductance of the cavity. Furthermore, it has been found that any difference between the thickness of the soldering layers 120a by which the external body is held to the printed circuit board and the soldering layer 120b by which the internal rostrum is held to the printed circuit board tends to have a critical impact on the electromagnetic properties of the resonator cavity: a difference in thickness between solder mounting each component significantly alters the width of a capacitive gap generated between the distal end of the rostrum (also known as a re-entrant stub) and the main body. It can thus be seen that the deviation in thickness of soldering layers leads to a significant deviation in the total capacitance of a resonator.

[0012] Experimental evidence has shown that surface-mount re-entrant cavities and filters composed of them cannot be accurately fabricated unless the soldering layer thickness is either absolutely controlled during the re-flow process and properly taken into account during the design process, or that the impact if the soldering layer on the cavity performance is minimised. It has been found that the thickness of the soldering layers is highly dependent on manufacturing method (for example, the amount of solder used, and the re-flow temperature profile). It has been found that it is extremely difficult to accurately determine the impact of the manufacturing method and take it into account during the design process.

[0013] In particular it has been found for those components, typically the stub 110, to which access cannot be guaranteed throughout the manufacturing process, it is particularly difficult to control the thickness of the resulting soldering layer 120b. Components to which access can be guaranteed throughout the manufacturing process (for example, external body 100) may be more accurately mounted on a printed circuit board by the application of force during re-flow or by controlling the amount of solder used. However, without the ability to control the mounting process in respect of both components (100, 110) it is not possible to accurately fabricate re-entrant cavities and filters composed of re-entrant cavities on a printed circuit board.

[0014] It will be appreciated that deviations in the total capacitance and inductance of a resonator significantly affect operation of a resonator and particularly those features of a resonator to be used in wireless telecommunications systems. In order to meet the strict rules relating to the power spectrum of the transmittal signal and other features desirable in a wireless telecommunications resonator it is necessary to construct a resonator more reliably.

[0015] The first aspect recognises that it is possible to design re-entrant cavities to be mounted on a printed circuit board that are much less sensitive to the thicknesses of the soldering layers mounting components to a printed circuit board.

[0016] The first aspect further recognises that by controlling the mounting process it is possible to more reliably construct a resonator having desirable characteristics. It will be appreciated that by constructing a resonator in which there is a structure operable to prevent more than one component mounting induced variation in a capacitance gap, it is more likely that the properties of the resulting resonator can be finely controlled.

[0017] It will be appreciated that the substrate may be a printed circuit board or any other suitable surface that includes appropriate conductive means.

[0018] In one embodiment, the stub is integrally formed with said body.

[0019] It will be appreciated that one possibility regarding an alignment error reducing structure operable to prevent more than one component mounting induced variation in said capacitance gap is the provision of a stub integrally formed with the body. The stub and body may be formed as a unitary member. The stub and body may be bonded together prior to mounting on the substrate. Each such arrangement ensures that the mounting of the body onto a substrate introduces only one component mounting variation to a substrate mounted resonator, since the relationship between the stub and the body is predominantly controlled by component construction rather than a mounting process.

[0020] Accordingly, the capacitive gap which defines the capacitance of the resonator is formed in a known manner between a stub integrally formed with the body and a surface with which the gap can be more finely controlled. In this way, it can be ensured that the electromagnetic behaviour of the structure can be predicted more accurately.

[0021] In one embodiment, the alignment error reducing structure comprises one or more alignment projections and co-operating alignment holes, each provided on one or other of the stub or the substrate.

[0022] Accordingly, the alignment of the substrate body and stub may be better controlled by provision of co-operating projections and holes. It will be understood that it is possible to provide co-operating alignment holes on one or other of the stub and the substrate or also to provide alignment projections and holes on one or other of the body or substrate in order to provide sufficient alignment of the components of the resonator on the substrate and with respect to each other.

[0023] In one embodiment, the stub is substantially elongate.

[0024] In one embodiment, the capacitance gap is defined between a distal end of the stub and the substrate.

[0025] It will be appreciated that such an arrangement may be of particular use when the stub is integrally formed with the body since the defining capacitive gap may be formed between the elongate stub depending from a top surface of the body towards the surface of the substrate.

[0026] In one embodiment, the stub comprises an elongate stem portion and a head member of greater diameter than the stem portion.

[0027] In one embodiment, the capacitance gap is defined between a radially outer surface of the head portion of the stub and a surface of the body.

[0028] Accordingly, by forming a mushroom-like re-entrant stub it can be seen that the capacitative gap which predominantly defines the capacitance of the cavity can be supported predominantly between the sidewalls of the head of the mushroom-like stub and the sidewalls of the external part of the cavity, that is to say, the body. It will be appreciated that if the gap between the top of the body and the top face of the mushroom-like stub is designed to be sufficiently large, the contribution to the total capacitance of the cavity from that gap is relatively minor and, as a result, the capacitance of the cavity becomes substantially independent of the thicknesses of the internal and external soldering layers by which stub and body are mounted to the substrate. Such an arrangement ensures that the capacitance of the cavity is determined by the dimensions of the gap between the sides of the head of the stub and the walls of the body. Such an arrangement is particularly advantageous if used in conjunction with co-operating projections and alignment holes, though it will be appreciated that any misalignment between stub and body in a vertical sense is less detrimental to the operation of such a re-entrant resonator since if the stub head is closer to one sidewall of the body it will be further away from the other sidewall of the body and induced errors are likely to substantially "balance" such that the resonator operates substantially as designed.

[0029] In one embodiment, the stub is mounted on the substrate.

[0030] In one embodiment, the stub and the body have a substantially similar cross-sectional shape.

[0031] In one embodiment, the body and the stub are substantially circular in cross-section.

[0032] Accordingly, it will be understood that by ensuring that the body and the stub are substantially similar in cross-section that the capacitative gap formed between the stub and the body may be substantially uniform. In the case that the body and stub are substantially circular in cross-section, the resulting capacitive gap is substantially annular.

[0033] In one embodiment, the body is formed from a plastics material and coated with a conductive material.

[0034] In one embodiment, the stub is formed from a plastics material and coated with a conductive material.

[0035] Accordingly, the resulting resonator may be lightweight and yet still function correctly. Furthermore it is easier to form plastic components of the correct dimension than to mill solid metal components in the same manner. An appropriate metal coating may be aluminium or, copper, or equivalent conductors.

[0036] In one embodiment, the mounting comprises soldering. Accordingly, the mounting process may be simply and effectively carried out.

[0037] A second aspect provides a method of forming a resonator, said method comprising: providing a substrate;
mounting a body on the substrate, the arrangement of the body and the substrate defining a resonant cavity;
providing a stub which extends into the resonant cavity;
the resonant cavity having a capacitance predominantly defined by a capacitance gap between the stub and a surface of the resonant cavity; and providing an alignment error reducing structure operable to prevent more than one component mounting induced variation in the capacitance gap.

[0038] In one embodiment, the method further comprises the step of forming the stub integrally with the body.

[0039] In one embodiment, the method further comprises the step of providing, on one or other of the stub or the substrate, an alignment error reducing structure comprising one or more alignment projections and co-operating alignment holes.

[0040] In one embodiment, the stub is substantially elongate.

[0041] In one embodiment, the capacitance gap is defined between a distal end of the stub and the substrate.

[0042] In one embodiment, the stub comprises an elongate stem portion and a head member of greater diameter than the stem portion.

[0043] In one embodiment, the capacitance gap is defined between a radially outer surface of the head portion of the stub and a surface of the body.

[0044] In one embodiment, the method further comprises the step of mounting the stub on the substrate.

[0045] In one embodiment, the stub and the body have a substantially similar cross-sectional shape.

[0046] In one embodiment, the body and the stub are substantially circular in cross-section.

[0047] In one embodiment, the method further comprises the step of forming the body from a plastics material and coating the body with a conductive material.

[0048] In one embodiment, the method further comprises the step of forming the stub from a plastics material and coating the stub with a conductive material.

[0049] In one embodiment, the step of mounting comprises soldering.

[0050] Further particular and preferred aspects of the present invention 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.

BRIEF DESCRIPTION OF THE DRAWINGS

[0051] Embodiments of the present invention will now be described further, with reference to the drawings in which:

Figure 1 is a schematic cross-sectional illustration of a resonator in accordance with one embodiment;

Figure 2 is a schematic cross-sectional illustration of a resonator in accordance with a second embodiment;

Figure 3 is a schematic cross-sectional illustration of a resonator in accordance with a third embodiment;

Figures 4a & 4b illustrate schematically a method of constructing a resonator in accordance with a fourth embodiment;

Figure 5 illustrates schematically a cross-sectional view of a resonator in accordance with a fifth embodiment;

Figure 6 illustrates schematically a cross-sectional view of a resonator in accordance with a sixth embodiment; and

Figure 7 illustrates schematically a cross-sectional view of a printed circuit board mounted cavity resonator.

DESCRIPTION OF THE EMBODIMENTS

[0052] Figure 1-illustrates schematically a resonator in accordance with a first embodiment. A re-entrant stub resonator 1 comprises a printed circuit board 2 having a conductive upper layer 3, a body 4 and a stub 5. Body 4 is mounted on the metallic conductive upper layer 3 of PCB 2 via solder layers 6a, 6b. The body 4 is soldered to PCB 2 and defines a cavity 7. A stub 5 extends into the cavity. A capacitive gap 8 is defined between the stub 5 and the upper surface of the PCB 2. In use, a signal is introduced into cavity 5 via signal paths 9 provided on the upper PCB metallic layer.

[0053] In the embodiment shown in Figure 1, the surface mounted re-entrant cavity is formed from a single component mounted on the surface of printed circuit board 2. In such an approach, the re-entrant stub 5 is moulded together with the external body of the cavity 4. That single component is coated with a thin film of a metal. For such a configuration, the gap that predominantly defines the capacitance of the cavity is formed between re-entrant stub 5 and the surface of the PCB on which body 4 is mounted. In this way, it is ensured that the electromagnetic behaviour of the structure can be more accurately predicted by providing some means of controlling the thickness of the external soldering layer, for example, by suitable application of pressure during a soldering process.

[0054] It will be appreciated that accurate fabrication of a surface mount re-entrant resonator is improved since soldering of an internal, inaccessible, part housed within the body is no longer required.

[0055] Figure 2 illustrates schematically a cross section of a resonator according to a second embodiment. Identical numbers to those used in Figure 1 have been used to indicate analogous parts throughout Figure 2 and the following Figures. According to the second embodiment, a re-entrant stub 5 has a substantially mushroom-like form (that is to say, it has a substantially disc-like head portion 5a supported by a stem 5b of smaller cross-section). In the embodiment shown, the defining capacitive gap 8 is provided between the sidewalls of body 4 and the sidewalls of the head of the mushroom-like stub. It will be appreciated that the gap 8 in this embodiment is substantially annular in form.

[0056] In this arrangement, the gap between the top wall of the body 4 and the upper surface of the mushroom-like stub (the top of the disc-like head) has been designed to be sufficiently large that the contribution that cap makes to the total capacitance of the cavity is minor. In this arrangement, the total capacitance of the cavity becomes substantially independent of the thicknesses of internal and external soldering layers and the difference between them, since the capacitive gap is formed as an annular gap between the stub head and the sidewall or the body.

[0057] In this embodiment, to ensure the re-entrant stub 5 is aligned with the external body 4, the stub 5 is secured and maintained in position during the soldering re-flow process by use of a pin 10 formed on the re-entrant stub which fits within the corresponding hole on the PCB 2 on which the resonator 1 is mounted. Stub 5 is soldered to the PCB via solder layer 6c.

[0058] In the arrangement shown in Figure 2, the capacitance of the cavity resonator is determined by the particular dimensions (including width and height) of the gap 8 provided between the head of the stub and the inner surface of body 4.

[0059] The cavity design of Figure 2 is used to reduce electromagnetic sensitivity to thickness of soldering layers 6a, 6b, 6c. It also provides a larger range for its total available capacitance by allowing for a greater range of capacitance gap dimensions. The capacitive gap of Figure 2 is supported across a larger total cross-sectional area (the circumference of the head, multiplied by the depth of the head) than that shown in Figure 1, and thus the total capacitance of the cavity can be siginificantly increased or decreased to achieve application-dependent requirements regarding, for example, quality factor, or form factor of the cavity. It will be understood that the characteristics of the resonator may be adapted by, amongst other things, altering the height of the gap or the width of the annular gap.

[0060] Figure 3 illustrates schematically a cross-section of a resonator according to a third embodiment. Figure 3 illustrates an embodiment with significantly less dependence upon the soldering layers 6a, 6b, 6c. In this arrangement, a re-entrant mushroom-like stub 5 is formed integrally as part of body 4 and therefore combines the advantages of the cavities shown in Figures 1 and 2.

[0061] Figure 4a and Figure 4b illustrate schematically a method of constructing a resonator on accordance with a fourth embodiment.

[0062] Figure 4b shows a cavity design similar to that shown in Figure 1 as implemented using stripline PCB technology. As shown in Figure 4b, a PCB surface mounted re-entrant cavity can be formed by using stripline technology. In this approach, a resonator 21 is formed from three discrete parts. The resonator 21 comprises a body 24a, 24b and a stub 25. Each of those parts is formed from plastic coated with a metal layer. In the embodiment shown, the re-entrant stub forms part of, and is integrally formed with, body part 24a. The two parts of the body 24a, 24b are soldered either side of the printed circuit board 22, via solder layers 26a, 26b, to form a cavity 27. In such a configuration, the components that are soldered on opposing sides of the printed circuit board are connected via copper vias 30 which have been embedded within the printed circuit board. A schematic representation of the array of vias connecting upper and lower body parts 24a, 25b is shown in Figure 4a. Figure 4a also shows the signal feeding network embedded within PCB 22. The signal is sent to enter the resonant cavity of resonator 21 via ports 31.

[0063] In this case, the defining capacitive gap 28 is formed between the distal end of stub 25 formed as part of body 24a and the PCB 22, and thus exhibits advantages as described with respect to Figure 1, such that the properties of the resulting resonant cavity are substantially less dependent upon the thickness of the solder layers by which components are mounted to the PCB.

[0064] Figure 5 illustrates schematically a cross-section of a resonator in accordance with a fifth embodiment. Figure 6 illustrates schematically a cross-section of a resonator in accordance with a sixth embodiment. The numbering convention of Figure 4a and Figure 4b has been implemented for analogous components throughout Figures 5 and 6.

[0065] The embodiments of Figures 5 and 6 are analogous to those shown in Figures 2 and 3 and exhibit the same advantages as those embodiments. That is to say, the capacitance gap 28 is formed between the stub and the sidewalls of body 24a as also shown in the embodiments of Figures 2 and 3. Both Figure 5 and Figure 6 are specific implementations of those geometries, implemented using stripline technology. In these implementations it will be understood that the properties of the PCB mounted re-entrant cavity resonator are substantially independent of the solder layers by which components are mounted on the PCB, since the defining capacitive gap is formed between the sides of the enlarged head of the stub and the sidewalls of the cavity and that gap is formed such that it has characteristics which are substantially independent from the solder layers.

[0066] 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 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 comprising:

a substrate;
a body mounted on said substrate, the arrangement of said body and said substrate defining a resonant cavity;
a stub which extends into said resonant cavity;
the resonant cavity having a capacitance predominantly defined by a capacitance gap between said stub and a surface of said resonant cavity; and
an alignment error reducing structure operable to prevent more than one component mounting induced variation in said capacitance gap.

2. A resonator according to claim 1, wherein said stub is integrally formed with said body.

3. A resonator according to claim 1, wherein said alignment error reducing structure comprises one or more alignment projections and co-operating alignment holes, each provided on one or other of said stub or said substrate

4. A resonator according to any preceding claim, wherein said stub is substantially elongate.

5. A resonator according to any preceding claim, wherein said capacitance gap is defined between a distal end of said stub and said substrate.

6. A resonator according to any one of claims 1 to 4, wherein said stub comprises an elongate stem portion and a head member of greater diameter than said stem portion.

7. A resonator according to claim 6, wherein said capacitance gap is defined between a radially outer surface of said head portion of said stub and a surface of said body.

8. A resonator according to any preceding claim, wherein said stub is mounted on said substrate.

9. A resonator according to any preceding claim, wherein said stub and said body have a substantially similar cross sectional shape.

10. A resonator according to claim 9, wherein said body and said stub are substantially circular in cross-section.

11. A resonator according to any preceding claim, wherein said body is formed from a plastics material and coated with a conductive material.

12. A resonator according to any preceding claim, wherein said stub is formed from a plastics material and coated with a conductive material.

13. A resonator according to any preceding claim, wherein said mounting comprises soldering.

14. A method of forming a resonator, said method comprising:

providing a substrate;

mounting a body on said substrate, the arrangement of said body and said substrate defining a resonant cavity;
providing a stub which extends into said resonant cavity;
the resonant cavity having a capacitance predominantly defined by a capacitance gap between said stub and a surface of said resonant cavity; and
providing an alignment error reducing structure operable to prevent more than one component mounting induced variation in said capacitance gap.

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

1. A resonator (1) comprising:

a substrate (2);
a body (4) mounted on said substrate, the arrangement of said body (4) and said substrate (2) defining a resonant cavity (7);
a stub (5) which extends into said resonant cavity; an elongate stem portion (5a) and a head member (5b) and a head member (5a) of greater diameter than said stem portion;
the resonant cavity having a capacitance predominantly defined by a capacitance gap (8) between a radially outer surface of said head member (5a) of said stub (5) and a surface of said body (4); and

wherein said stub (5) is integrally formed with said body (4) as an alignment error reducing structure operable to prevent more than one component mounting induced variation in said capacitance gap (8).

2. A resonator (1) according to any preceding claim, wherein said stub (5) is substantially elongate.

3. A resonator according to any preceding claim, wherein said stub (5) and said body (4) have a substantially similar cross sectional shape.

4. A resonator according to claim 3, wherein said body (4) and said stub (5) are substantially circular in cross-section.

5. A resonator according to any preceding claim, wherein said body (4) is formed from a plastics material and coated with a conductive material.

6. A resonator according to any preceding claim, wherein said stub (5) is formed from a plastics material and coated with a conductive material.

7. A resonator according to any preceding claim, wherein said mounting comprises soldering.

8. A method of forming a resonator (1), said method comprising:

providing a substrate (2);
mounting a body (4) on said substrate (2), the arrangement of said body (4) and said substrate (2) defining a resonant cavity (7);
providing a stub comprising an elongate stem portion (5b) and a head member (5a) of greater diameter than said stem portion (5b) which extends into said resonant cavity (7);
the resonant cavity (7) having a capacitance predominantly defined by a capacitance gap (8) between a radially outer surface of said head member (5a) of said stub (5) and a surface of said body (4); and
wherein said stub (5) is integrally formed with said body (4), thus providing an alignment error reducing structure operable to prevent more than one component mounting induced variation in said capacitance gap (8).

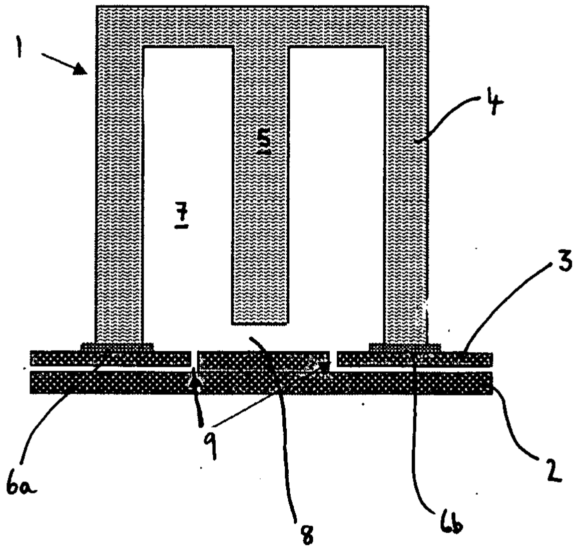

Figure 1

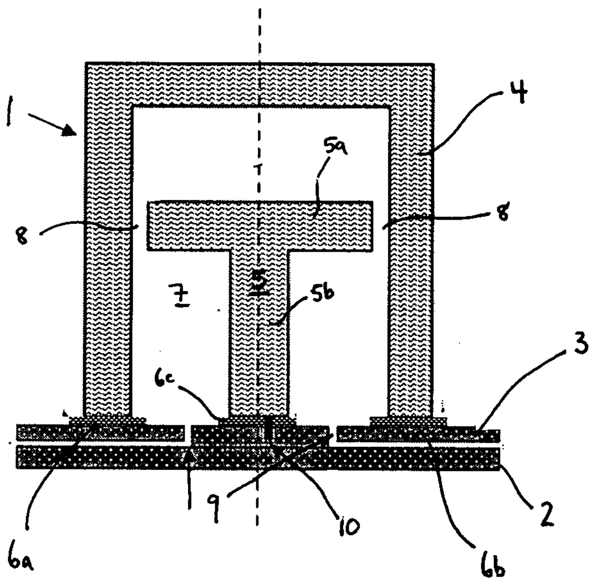

Figure 2

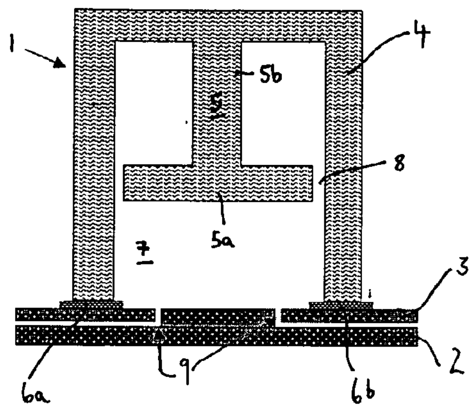

Figure 3

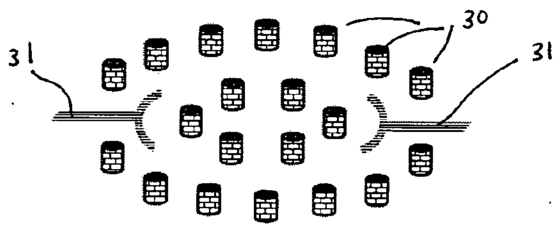

Figure 4a

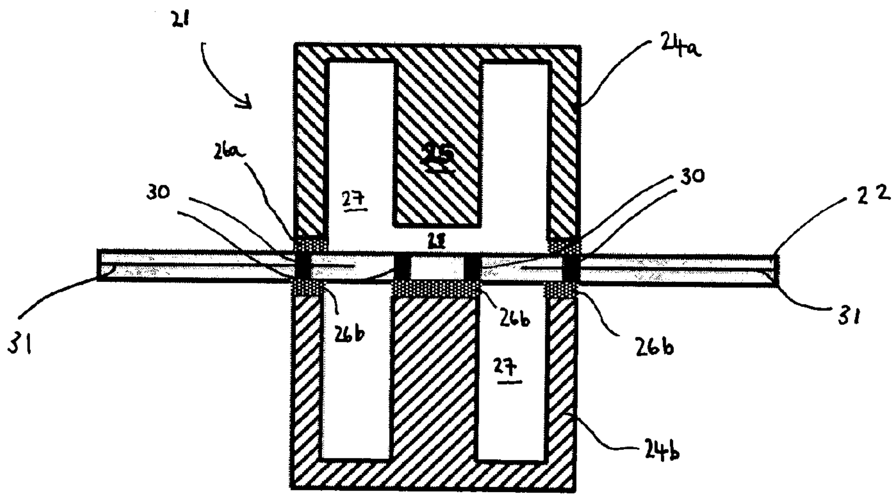

Figure 4b

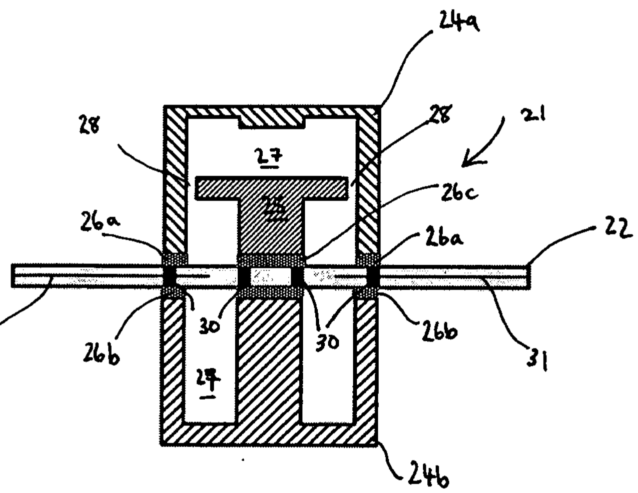

Figure 5

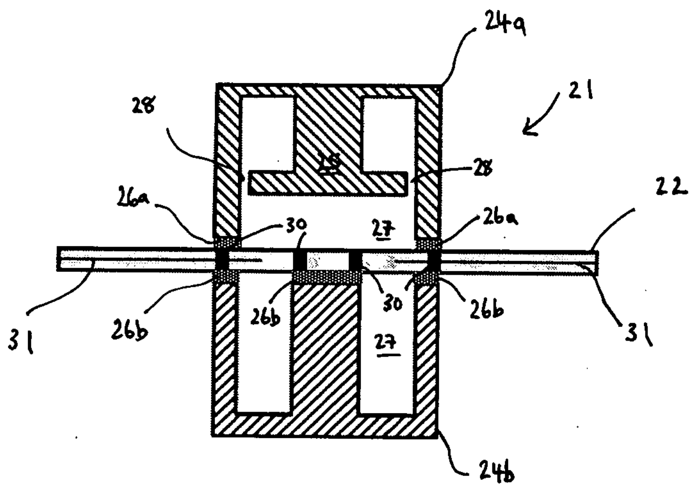

Figure 6

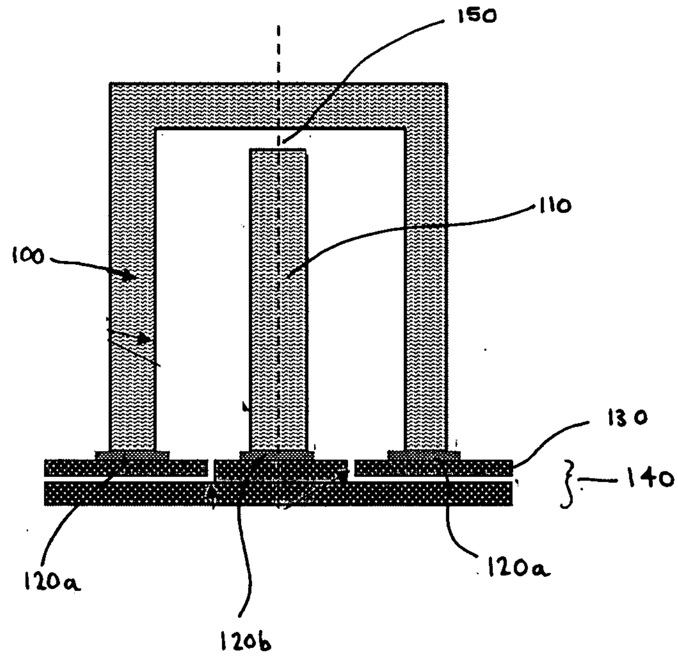

Figure 7

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 09 36 0053

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	US 2008/067948 A1 (HESSELBARTH JAN [IE]) 20 March 2008 (2008-03-20) * paragraph [0002] - paragraph [0005]; figure 1 * * paragraph [0023] - paragraph [0027]; figures 2-5 *	1-5,9-14 6-8	INV. H01P7/04
Y	WO 99/30383 A2 (LK PRODUCTS OY [FI]; VISTBACKA TAPANI [FI]; NIIRANEN ERKKI [FI]; ALA K) 17 June 1999 (1999-06-17) * page 4, line 24 - page 5, line 20; figure 1 *	6-8	
X	US 2008/068104 A1 (HESSELBARTH JAN [IE]) 20 March 2008 (2008-03-20) * paragraph [0019] - paragraph [0021]; figure 2a * * paragraph [0023] - paragraph [0025]; figures 3,4 *	1,14	
X	EP 1 903 631 A1 (MT S R L [IT]) 26 March 2008 (2008-03-26) * paragraph [0018] - paragraph [0024]; figures 1-3 * * paragraph [0033] - paragraph [0044]; figures 4-6 *	1,14	TECHNICAL FIELDS SEARCHED (IPC) H01P
A	WO 00/13256 A2 (ALLGON AB [SE]; RAETY TUOMO [FI]; KANERVO ANTTI [FI]) 9 March 2000 (2000-03-09) * page 9, line 9 - line 28; figures 2a,2b *	1,14	
A	JP 08 195607 A (KOKUSAI ELECTRIC CO LTD) 30 July 1996 (1996-07-30) * abstract; figures 1-2 *	1,14	

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
The Hague	27 April 2010	Pastor Jiménez, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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