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(54) **A ground bridge, an antenna device comprising such a ground bridge, and a portable radio communication device comprising such an antenna device**

(57) The present invention relates to a ground bridge comprising an electrically conductive element (7) and at least one ground plane connection portion (8), wherein the electrically conductive element (7) is configured to be arranged in the same plane as a ground plane (3) of

a portable radio communication device comprising the ground bridge, and wherein the at least one ground plane connection portion (8) is configured to electrically direct connect the electrically conductive element (7) to the ground plane (3).

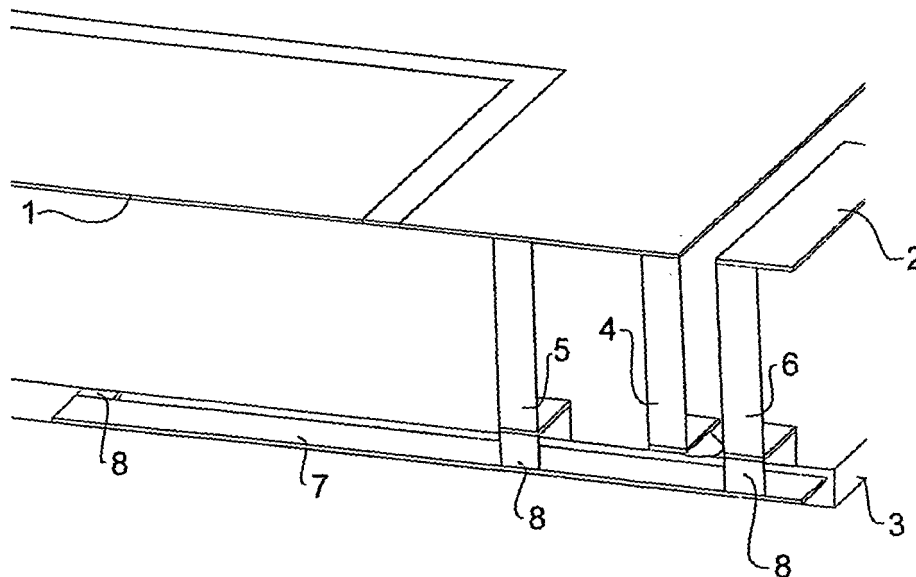


Fig. 4

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Description

FIELD OF INVENTION

[0001] The present invention relates generally to antennas, and particularly to a ground bridge for an antenna device for a portable radio communication device, such as a mobile phone or similar.

BACKGROUND

[0002] The market for portable radio communication devices, such as mobile phones, PDA, portable computers and similar devices, is today very competitive, which puts tough demands on the manufacturers. Furthermore, antennas of such devices many times only have access to limited space of different shapes.

[0003] To increase design flexibility for antenna manufacturers it is desirable to have off ground spacing to work with, since in such a case no regard needs to be taken to wiring or components on a printed wiring board. Further, the bandwidth of an on-ground antenna, such as PIFA, can preferably be increased by removing parts of the ground plane under the antenna, but when the parts of the ground plane is removed from under the antenna SAR is at the same time increased, which is undesirable.

[0004] In Figs. 1 and 2 an illustrative partly off-ground PIFA is shown, comprising a driven radiating element 1 having a feed 4 and a ground 5, and a parasitic element 2 having a ground 6. The PIFA is partly off-ground a ground plane 3, made up by a printed wiring board. By providing the PIFA as partly off-ground its bandwidth is increased, but at the cost of increased SAR.

[0005] In Fig 3 another illustrative partly off-ground PIFA is shown, comprising a driven radiating element 1 having a feed 4 and a ground 5, and a parasitic element 2 having a ground 6. The PIFA is partly off-ground a ground plane 3, made up by a printed wiring board, which ground plane 3 is unevenly cut.

SUMMARY OF THE INVENTION

[0006] To provide an antenna with off-ground portions only at desired positions the printed wiring board need to be cut unevenly, resulting in tongues and similar areas. At an insight of the inventors design flexibility, even late in design stages, can be achieved by providing a ground bridge in an off-ground area of an antenna device.

[0007] Such design flexibility is according to the present invention attained by a ground bridge, an antenna device, and a portable radio communication device, respectively, as defined by the appended claims.

[0008] By providing a ground bridge comprising an electrically conductive element and at least one ground plane connection portion, wherein the electrically conductive element is configured to be arranged in the same plane as a ground plane of a portable radio communication device comprising the ground bridge, and wherein the at least one ground plane connection portion is configured to electrically direct connect the electrically conductive element to the ground plane, improved design flexibility is achieved since the ground bridge is much more easily redesigned than the printed wiring board. Further, by preferably having at least two ground plane connection portions it is easier to avoid undesired resonances in the ground bridge, which e.g. could increase SAR or interfere with desired antenna characteristics. Another advantage with a ground bridge according to the present invention is that its use reduces influences to the antenna device from the user.

[0009] By having at least two ground plane connection portions configured to connect the ground bridge to the ground plane on either side of the feed portion, undesired resonance in the ground bridge is effectively avoided.

[0010] The ground bridge is preferably configured to be snap-fitted to the ground plane, whereby positioning easily is achieved.

[0011] By having at least two ground plane connection portions positioned on the electrically conductive element such that any protruding part of the electrically conductive element is non-resonant for an operating frequency of the antenna device, SAR values can be reduced.

[0012] The ground plane is preferably made up of a printed wiring board of a portable radio communication device. The printed wiring board preferably also comprises a straight edge across the portable radio communication device, off which edge the radiating element protrudes with its off ground part.

[0013] Further features and advantages of the present invention will be evident from the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The present invention will become more fully understood from the detailed description of embodiments given below and the accompanying figures, which are given by way of illustration only, and thus, are not limitative of the present invention, wherein:

Fig. 1 illustrates, in an elevation view, a partly off-ground antenna device according to known technique.

Fig. 2 shows, in a blown up side elevation view, the antenna device illustrated in Fig. 1.

Fig. 3 illustrates, in an elevation view, another partly off-ground antenna device according to known technique.

Fig. 4 illustrates, in a side elevation view, a part of an antenna device according to a first embodiment of the present invention.

Fig. 5 shows, in a side elevation view, the antenna device illustrated in Fig. 4.

Fig. 6 illustrates, in an elevation view, a part of an antenna device according with an alternative configuration compared to that illustrated in Figs. 4-5.

Fig. 7 shows, in a blown up view, the antenna device illustrated in Fig. 6.

Fig. 8 illustrates, in an elevation view, a part of an antenna device according to a second embodiment of the present invention.

Fig. 9 illustrates, in an elevation view, a part of an antenna device according with an alternative configuration compared to that illustrated in Fig. 8.

Fig. 10 illustrates current concentrations and high E-field areas for a radiating element.

Fig. 11 illustrates a floating bridge according to a third embodiment of the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS

[0015] In the following description, for purpose of explanation and not limitation, specific details are set forth, such as particular techniques and applications in order to provide a thorough understanding of the present invention. However, it will be apparent for a person skilled in the art that the present invention may be practiced in other embodiments that depart from these specific details. In other instances, detailed description of well-known methods and apparatuses are omitted so as not to obscure the description of the present invention with unnecessary details.

[0016] A first embodiment of the present invention will now be described with reference to Figs. 4-5, which illustrate an antenna device according to the present invention.

[0017] The antenna device comprises a driven radiating element 1 and a parasitic element 2. The driven radiating element 1 has a feed portion 4 and a ground portion 5. The parasitic element 2 has a ground portion 6, but no feed portion. The ground portions 5 and 6 are connected to a ground plane 3, preferably made up by a printed wiring board of a portable radio communication device, such as a mobile phone, PDA, or similar device. The feed portion 4 is connected to RF circuitry of the portable radio communication device. The driven radiating element 1 and the parasitic element 2 are positioned partly off-ground the ground plane 3 and partly on ground the ground plane 3.

[0018] The antenna device further comprises a ground bridge including an electrically conductive element 7 and three ground connection portions 8. The electrically conductive element 7 of the ground bridge is positioned in

the off-ground part of the portable radio communication device, such that the electrically conductive element 7 is arranged between the feed portion 4 and a user of the portable radio communication device. The electrically conductive element 7 is connected to the ground plane 3 through the three ground connection portions 8. In this embodiment one ground connection portion 8 directly connects the electrically conductive element 7 to the ground plane 3, a second ground connection portion 8 connects the electrically conductive element 7 to the ground portion 5 of the driven radiating element 1, and a third ground connection portion 8 connects the electrically conductive element 7 to the ground portion 6 of the parasitic element 2.

[0019] The ground bridge is preferably made up the same way as the rest of the antenna device, e.g. a flexfilm comprising electrically conductive portions, supported by a dielectric carrier. A ground connection portion 8 going directly to the ground plane 3 require its own connector arrangement, whereas a ground connection portion that is connected via ground portion 5 of the driven radiating element 1 or ground portion 6 of the parasitic element 2 does not need a connector arrangement of its own since it is inherently connected to the ground plane 3.

[0020] The ground bridge could alternatively be included in the antenna device, wherein it could be a metal object snap-fitted into a carrier of the antenna device and then connected to the ground plane 3 by normal contacting means, such as clips or similar, or the metal object could itself create the connection. Further, the ground bridge is preferably snap fitted to the ground plane 3 and also to the ground portions 5 and 6 of the driven radiating element 1 and the parasitic element 2, respectively.

[0021] The ground connection portions 8 of the ground bridge are preferably arranged such that no part, or only small parts, of the electrically conductive element 7 protrudes out there from, in such a way that resonance could be generated therein, which would interfere with desired resonance frequencies of the antenna device. Further, the ground connection portions 8 of the ground bridge are preferably also arranged such that a slot created between the electrically conductive element 7 and the ground plane 3 is not tuned to any resonance frequency which would interfere with desired resonance frequencies of the antenna device.

[0022] By arranging the ground bridge between the user and the highest current concentration areas of the antenna device, e.g. around the feed portion 4, illustrated in Fig. 10, SAR is reduced. If at the same time the ground bridge is not arranged between the user and the highest E-field of the antenna device, e.g. portion of the driven radiating element 1 farthest from the feed portion 4 illustrated in Fig. 10, increased bandwidth is maintained even though SAR is kept low.

[0023] Although three ground connection portions have been described, at least one is sufficient to give desired properties. However, at least two ground connection portions makes it easier to avoid undesired res-

onances in the ground bridge, and the more ground connection portions utilized the more stability of the ground bridge can be achieved.

[0024] An alternative configuration of the ground bridge of the antenna device according to the first embodiment of the present invention is illustrated in Figs. 6-7, wherein the ground bridge comprises two ground connection portions 8, arranged at opposing sides of the electrically conductive element 7.

[0025] A second embodiment of the present invention will now be described with reference to Fig. 8. This second embodiment of the present invention is identical with the first embodiment described above, apart from the following. The ground plane 3 does not exhibit a straight edge across the portable radio communication device, off which edge the radiating element 1 protrudes with its off-ground part. The electrically conductive element 20 of the ground bridge is arranged in a part of the cut-out portion of the ground plane 3, to adapt e.g. for redesign late in design process of the antenna device. The ground bridge comprises two ground plane connection portions 8 at opposing portions thereof.

[0026] An alternative configuration of the ground bridge of the antenna device according to the second embodiment of the present invention is illustrated in Fig. 9, wherein the ground bridge comprises only one ground connection portion 8.

[0027] A third embodiment of the present invention will now be described with reference to Fig. 11. This third embodiment of the present invention is identical with the first embodiment described above, apart from the following. The antenna device further comprises a floating bridge 9 connected to the ground bridge. The connection to the ground bridge is through a low pass filter 10, which can be used to make the floating bridge look floating from an RF perspective. The low pass filter 10 can e.g. consist of one lumped component, or comprise more complex filter solutions. Since low frequency and DC signals can pass the low pass filter the floating bridge 9 can contain components 11 like speakers, vibration devices, etc. The floating bridge can also have further connections 12 to the ground plane 3 through filters.

[0028] The third embodiment of the present invention could easily be adapted to the configuration of the second embodiment of the present invention described above.

[0029] Radiating elements have in this description been illustrated with particular shapes, but for the present invention their particular shapes are not important and can have many different shapes. Further, the radiating elements have been described as partly on-ground and partly off-ground a ground plane, but the same principle with a ground bridge at desired positions is applicable also for a completely off-ground antenna, such as a monopole of an IFA (Inverted F-Antenna) antenna.

[0030] It will be obvious that the present invention may be varied in a plurality of ways. Such variations are not to be regarded as departure from the scope of the present invention as defined by the appended claims. All such

variations as would be obvious for a person skilled in the art are intended to be included within the scope of the present invention as defined by the appended claims.

Claims

1. A ground bridge **characterized in that** it comprises an electrically conductive element (7) and at least one ground plane connection portion (8), wherein said electrically conductive element (7) is configured to be arranged in the same plane as a ground plane (3) of a portable radio communication device comprising said ground bridge, and wherein said at least one ground plane connection portion (8) is configured to electrically direct connect said electrically conductive element (7) to said ground plane (3).
2. The ground bridge as claimed in claim 1, comprising at least two ground plane connection portions (8).
3. The ground bridge as claimed in claim 2, wherein said at least two ground plane connection portions (8) are connected to said electrically conductive element (7) at opposing portions thereof.
4. The ground bridge as claimed in any of claims 1-3, wherein said electrically conductive element (7) is configured to be arranged between a feed portion (4) of a radiating element (1) of an antenna device and a user of said portable radio communication device.
5. The ground bridge as claimed in claim 4, wherein said at least two ground plane connection portions (8) are configured to connect said ground bridge to said ground plane (3) on either side of said feed portion (4).
6. The ground bridge as claimed in any of claims 1-5, comprising a floating bridge connected to said electrically conductive element (7) through a low pass filter (10).
7. An antenna device for a portable radio communication device, comprising a radiating element (1) configured to be positioned at least partly off-ground a ground plane (3), a feed portion (4) and a ground portion (5), **characterized in that** it further comprises a ground bridge comprising an electrically conductive element (7) and at least one ground plane connection portion (8), wherein said electrically conductive element (7) is configured to be arranged in the same plane as said ground plane (3), and wherein said at least one ground plane connection portion (8) is configured to electrically direct connect said electrically conductive element (7) to said ground plane (3).

8. The antenna device as claimed in claim 7, wherein said ground bridge comprising at least two ground plane connection portions (8).
9. The antenna device as claimed in claim 8, wherein said at least two ground plane connection portions (8) are connected to said electrically conductive element (7) at opposing portions thereof.
10. The antenna device as claimed in claims 8 or 9, wherein said at least two ground plane connection portions (8) are configured to connect said ground bridge to said ground plane (3) on either side of said feed portion (4).
11. The antenna device as claimed in any of claims 7-10, wherein said electrically conductive element (7) is configured to be arranged between said feed portion (4) and a user of said portable radio communication device.
12. The antenna device according to any of claims 7-11, wherein said radiating element (1) is positioned partly over said ground plane (3) and partly off-ground said ground plane (3).
13. The antenna device according to any of claims 7-12, wherein a part of said radiating element (1), during use, exhibiting the highest electrical field is configured to be positioned off-ground said electrically conductive element (7) and off-ground said ground plane (3).
14. The antenna device according to any of claims 7-13, wherein said ground bridge is configured to be snap-fitted to said ground plane (3).
15. The antenna device according to any of claims 7-14, wherein said at least two ground plane connection portions (8) are positioned on said electrically conductive element (7) such that any part of said electrically conductive element (7) is non-resonant for an operating frequency of said antenna device.
16. The antenna device as claimed in any of claims 7-15, comprising a floating bridge connected to said electrically conductive element (7) through a low pass filter (10).
17. A portable radio communication device comprising a printed wiring board and an antenna device comprising a radiating element (1) configured to be positioned at least partly off-ground a ground plane (3), a feed portion (4) and a ground portion (5), **characterized in that** it further comprises a ground bridge comprising an electrically conductive element (7) and at least one ground plane connection portion (8), wherein said electrically conductive element (7)
- is configured to be arranged in the same plane as said ground plane (3), and wherein said at least one ground plane connection portion (8) is configured to electrically direct connect said electrically conductive element (7) to said ground plane (3).
18. The portable radio communication device as claimed in claim 17, wherein said ground bridge comprising at least two ground plane connection portions (8).
19. The portable radio communication device as claimed in claim 18, wherein said at least two ground plane connection portions (8) are connected to said electrically conductive element (7) at opposing portions thereof.
20. The portable radio communication device as claimed in claims 18 or 19, wherein said at least two ground plane connection portions (8) are configured to connect said ground bridge to said ground plane (3) on either side of said feed portion (4).
21. The portable radio communication device as claimed in any of claims 16-20, wherein said electrically conductive element (7) is configured to be arranged between said feed portion (4) and a user of said portable radio communication device.
22. The portable radio communication device as claimed in any of claims 16-21, wherein said radiating element (1) is positioned partly over said ground plane (3) and partly off-ground said ground plane (3).
23. The portable radio communication device as claimed in any of claims 16-22, wherein said printed wiring board includes said ground plane (3).
24. The portable radio communication device as claimed in any of claims 16-23, wherein said ground plane (3) comprises a straight edge across said portable radio communication device, off which edge said radiating element (1) protrudes with its off-ground part.
25. The portable radio communication device as claimed in any of claims 16-24, comprising a floating bridge connected to said electrically conductive element (7) through a low pass filter (10).

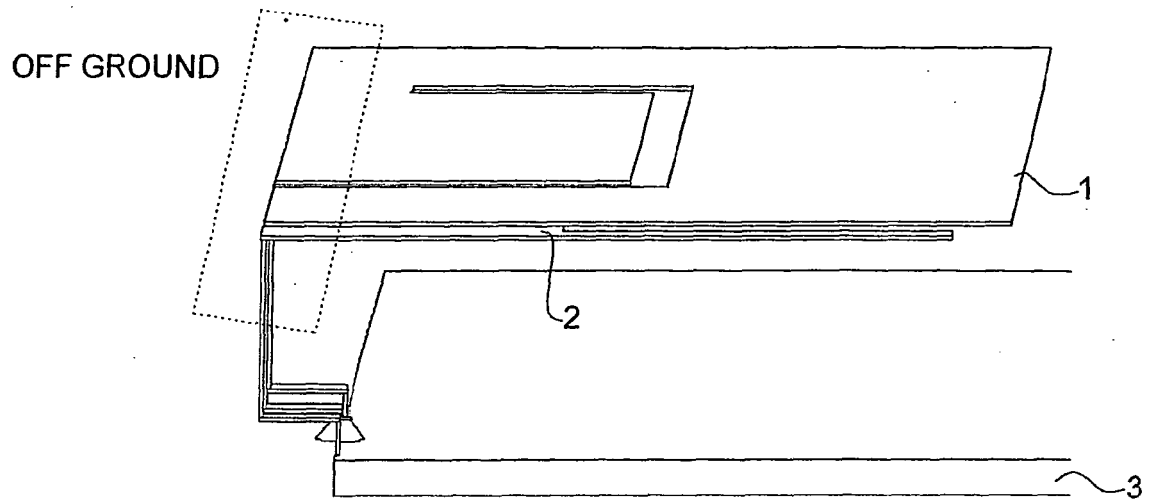


Fig. 1 PRIOR ART

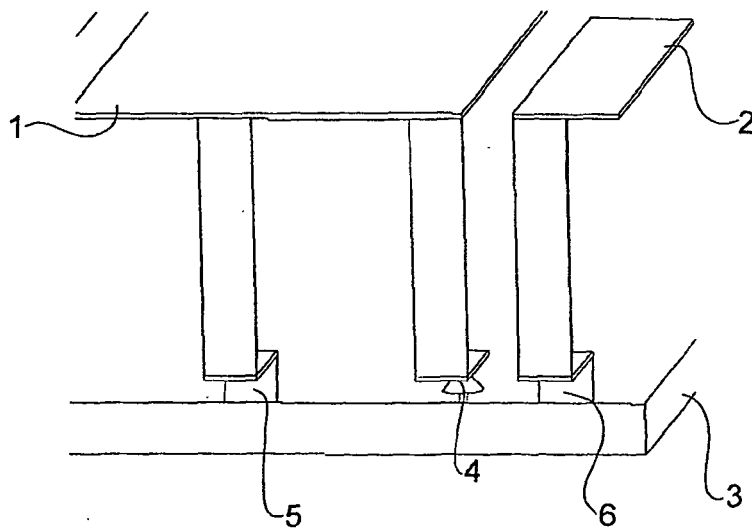


Fig. 2 PRIOR ART

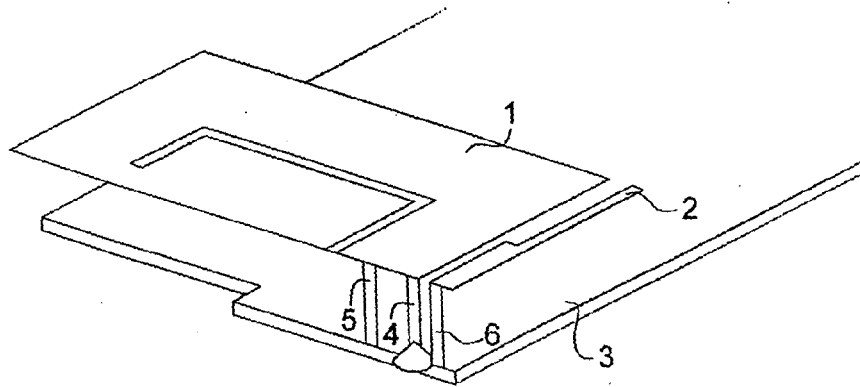


Fig. 3 PRIOR ART

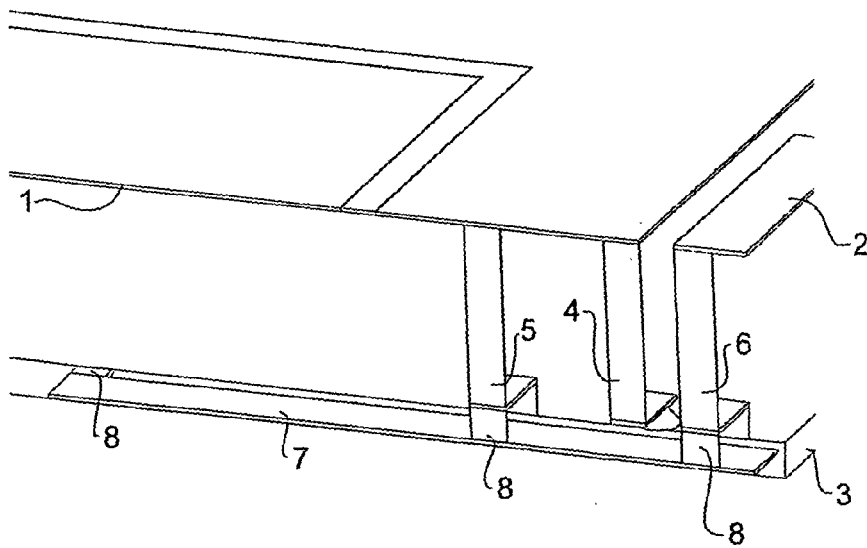


Fig. 4

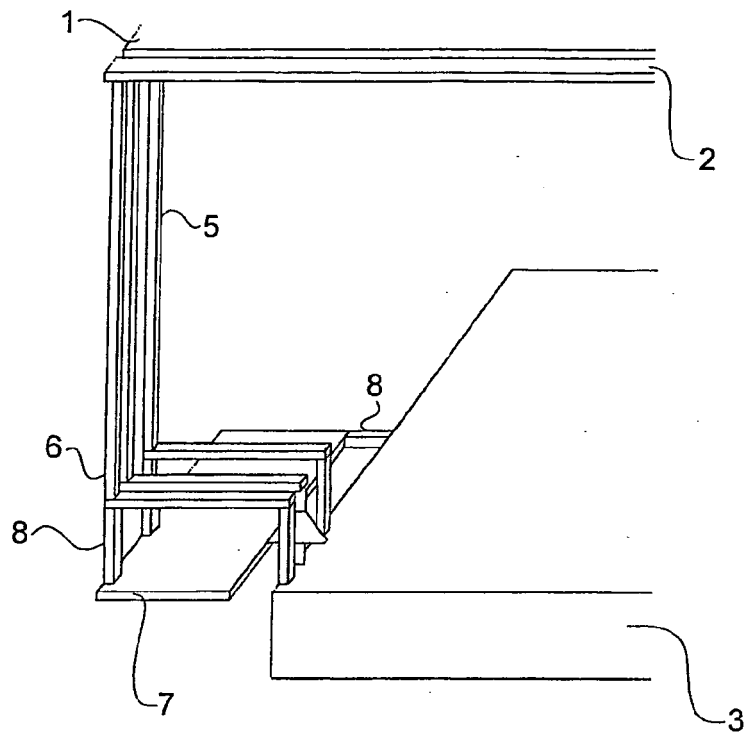


Fig. 5

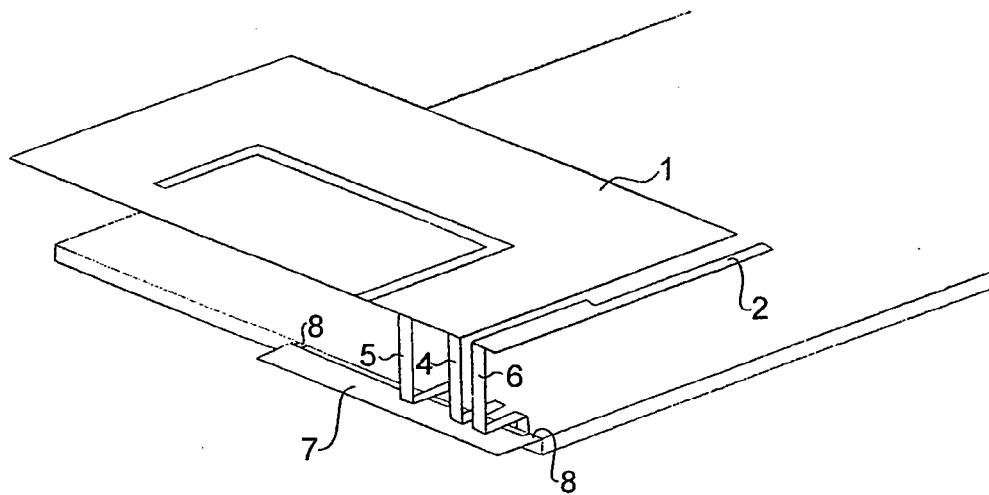


Fig. 6

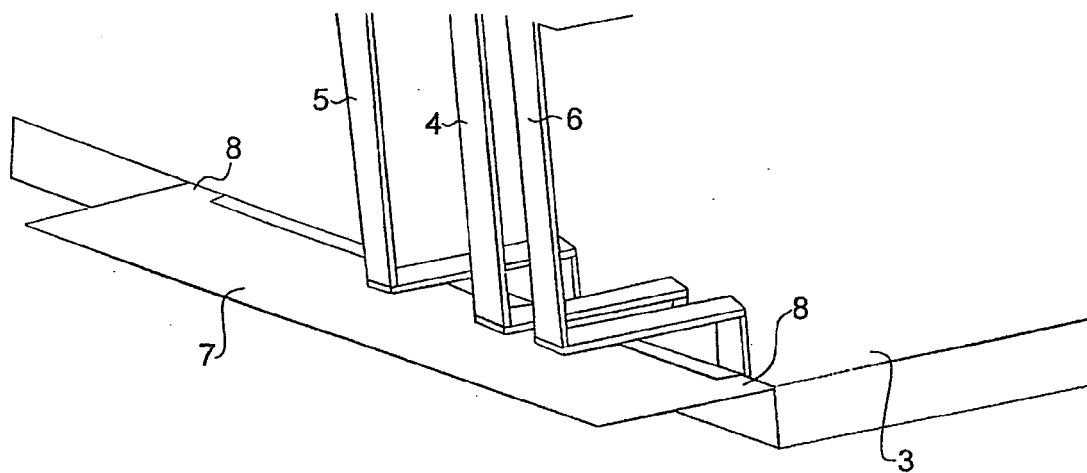


Fig. 7

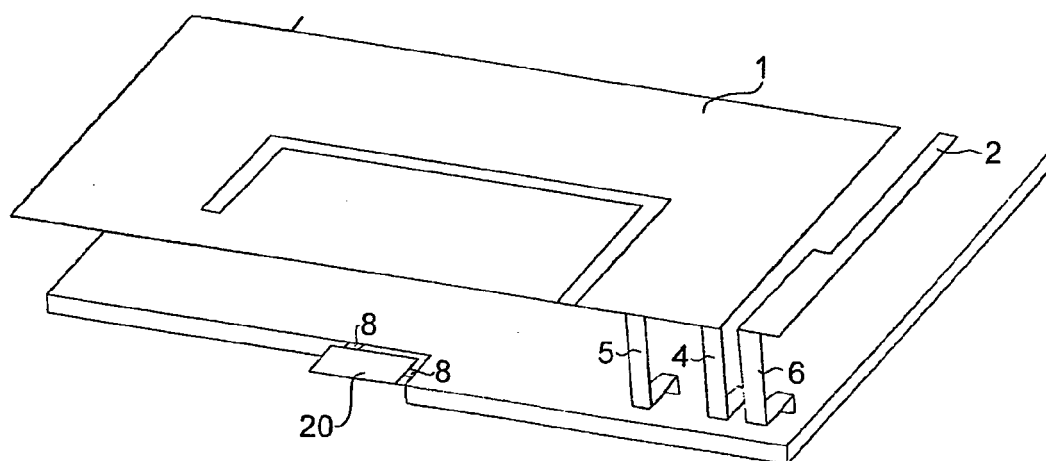


Fig. 8

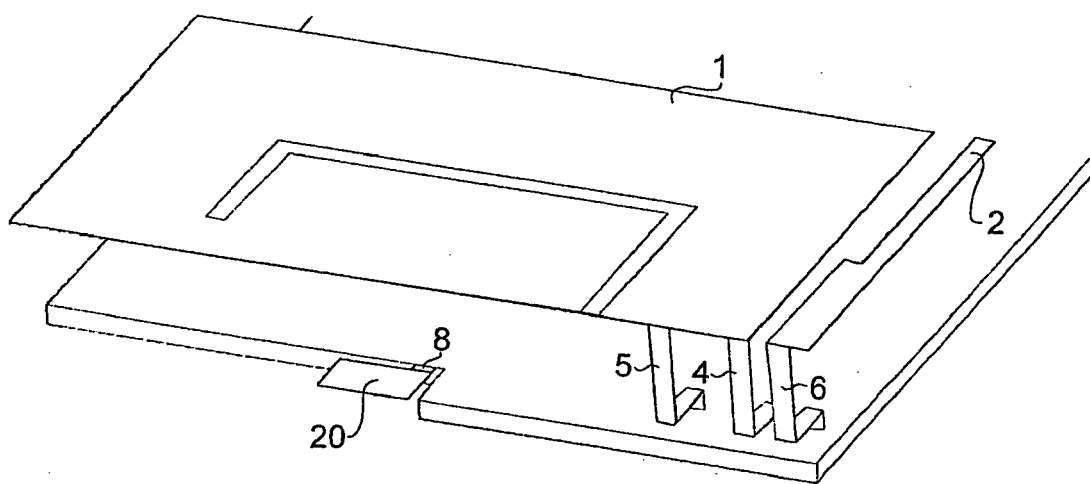


Fig. 9

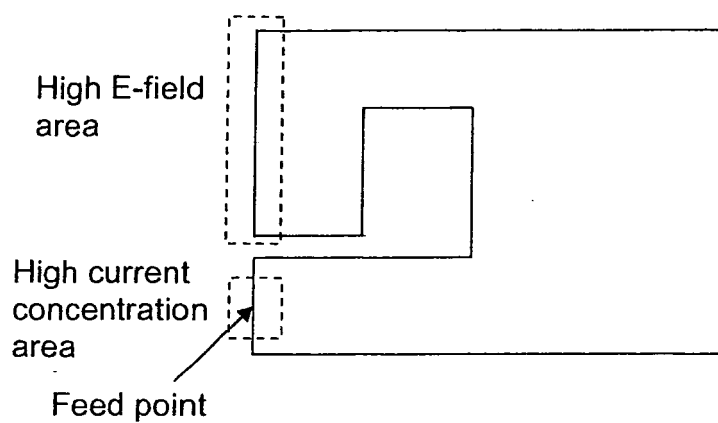


FIG. 10

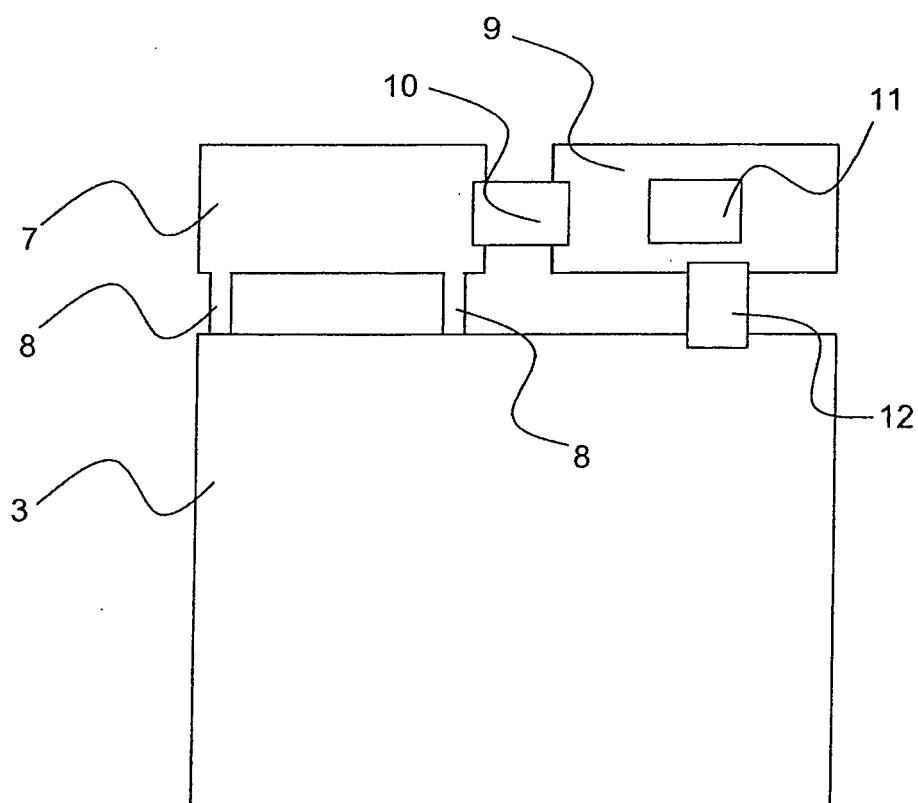


FIG. 11



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 08 44 5010

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 29 July 2008	Examiner Hüschelrath, Jens
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 08 44 5010

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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