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(54) In-built FM antenna

(57) The present invention relates to a portable communication device comprising a main unit (10) comprising a radio circuit (30) for connection to an antenna element, a ground plane (23), a loop antenna element (26) connected to the radio circuit and the ground plane, and

a tuning network between the radio circuit and the loop antenna element. The loop antenna element is provided at a distance (d) from the ground plane. This invention allows the provision of an FM antenna within the main unit that is less sensitive to changes in the surrounding area.

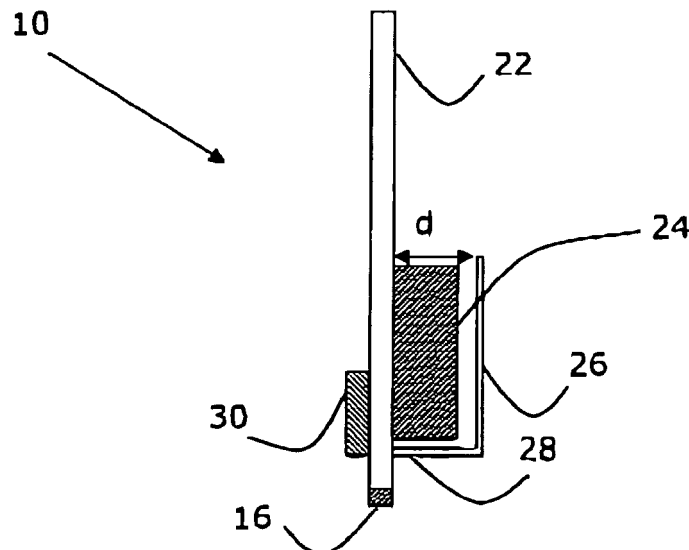


FIG. 2

Description

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention relates to the field of antennas and more particularly to a portable communication device with an antenna provided inside the device.

DESCRIPTION OF RELATED ART

[0002] Cellular phones are today provided with more and more functions. Examples of such functions are MP3 players and cameras.

[0003] At the same time the phones are getting smaller and smaller. There are therefore continuing efforts by the phone manufacturers to place devices providing this functionality in a very limited space inside the device.

[0004] One function that has evolved recently is the reception of radio stations, and then preferably FM radio. The phone then includes a radio receiver, which can be combined with the normal wireless network communication circuits of the phone. The problem that remains to be solved is then that of the antenna.

[0005] Standard in-built phone antennas used in other areas are normally quarter or half-wavelength antennas. However, such antennas have too big dimensions for being used as internal FM radio antennas. One such known antenna is described in WO-02/27862. Here a loop antenna element adapted for GPS signal reception is described for use in a phone.

[0006] This has led to the practice of using an accessory, such as a hands free set including an ear phone connected to the system connector of the phone via a long cord. This cord then functions as antenna. The system connector then also normally has connections for connection to charger, which is also an accessory. However, if a charger is connected to the phone at the same time as another accessory is working as antenna, the antenna is short circuited and then no radio signals can be received.

[0007] For that reason and other reasons, like for instance removal of the need for extra devices and the provision of a more aesthetic appearance, there have been suggested FM antenna solutions that are provided inside the phone.

[0008] These are essentially so-called electrical dipole solutions. In for instance EP-1294046, there is provided a meander antenna working as an FM antenna and in WO-2004/0191233 there are provided two parallel conductors working as an FM antenna inside a phone.

[0009] However the electrical dipole antenna is sensitive to changes in the environment. If for instance a user is holding the phone close to his body, the performance of such an antenna is affected in a negative way. An electrical dipole antenna is furthermore sensitive to changes in the size of the ground plane, which can occur because of for instance the connection of accessories to the phone. Also this change in size of the ground plane

degrades the performance of the electrical dipole antenna.

[0010] There is thus a need for an improved inbuilt FM antenna solution and especially one that is less sensitive to changes in the surrounding area.

SUMMARY OF THE INVENTION

[0011] The present invention is directed towards solving the problem of providing a portable communication device having a main unit with an improved inbuilt antenna, and especially one that is less sensitive to changes in the surrounding area.

[0012] The object of the present invention is thus to provide a portable communication device having a main unit with an in-built antenna and especially one that is less sensitive to changes in the surrounding area.

[0013] According to a first aspect of the present invention, this object is achieved by a portable communication device comprising:

a main unit comprising:

a radio circuit for connection to an antenna element,
a ground plane,
a loop antenna element connected to the radio circuit and the ground plane, and
a tuning network between the radio circuit and the loop antenna element, wherein the loop antenna element is provided at a distance from the ground plane.

[0014] A second aspect of the present invention is directed towards a portable communication device including the features of the first aspect, wherein the tuning network is arranged to tune the antenna to a radio station broadcast frequency range.

[0015] A third aspect of the present invention is directed towards a portable communication device including the features of the second aspect, wherein the frequency range is the range of 88 to 108 MHz.

[0016] A fourth aspect of the present invention is directed towards a portable communication device including the features of the first aspect, further comprising an electrical interface to auxiliary units, wherein the electrical interface has a connection to the ground plane.

[0017] A fifth aspect of the present invention is directed towards a portable communication device including the features of the fourth aspect, further comprising at least one auxiliary unit connectable to at least the connection to the ground plane of the electrical interface.

[0018] A sixth aspect of the present invention is directed towards a portable communication device including the features of the first aspect, wherein at least one element of the device is provided inside the loop of the loop antenna element.

[0019] A seventh aspect of the present invention is di-

rected towards a portable communication device including the features of the first aspect, wherein the loop antenna element has an essentially rectangular shape.

[0020] An eighth aspect of the present invention is directed towards a portable communication device including the features of the first aspect, wherein the distance between the loop antenna element and the ground plane is at least about 5 mm.

[0021] A ninth aspect of the present invention is directed towards a portable communication device including the features of the first aspect, wherein the cross section of the loop antenna element has an area in the range of 0.1 - 10 mm².

[0022] A tenth aspect of the present invention is directed towards a portable communication device including the features of the ninth aspect, wherein the cross section of the loop antenna element has a diameter of approximately 1 mm.

[0023] An eleventh aspect of the present invention is directed towards a portable communication device including the features of the first aspect, further comprising a notch filter connected between the loop antenna element and the tuning network.

[0024] A twelfth aspect of the present invention is directed towards a portable communication device including the features of the first aspect, in which it is a cellular phone.

[0025] The invention has the following advantages. It is not very sensitive to changes of the surrounding area, like changes of the ground plane or objects being close to the main unit. In fact an enlarged ground plane even enhances the antenna efficiency. There is furthermore no need to match any auxiliary units that are connected to the main unit, which is otherwise needed when for instance an ear phone cord is used as antenna. The loop antenna element is furthermore cheap to produce, occupies little space, can be very thin and does not increase the thickness of the main unit.

[0026] It should be emphasized that the term "comprises/comprising" when used in this specification is taken to specify the presence of stated features, integers, steps or components, but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] The present invention will now be described in more detail in relation to the enclosed drawings, in which:

fig. 1 schematically shows a front view of a cellular phone according to the invention,

fig. 2 schematically shows a side view of a circuit board inside the phone on which elements relevant to the present invention are placed including an antenna element,

fig. 3 schematically shows a front view of the circuit board of fig. 2 together with relevant elements, and

fig. 4 schematically shows different electrical elements inside the phone of fig. 1 for operating the antenna according to the present invention together with additional elements.

DETAILED DESCRIPTION OF EMBODIMENTS

[0028] A portable communication device according to the invention will now be described in relation to a cellular phone, which is a preferred variation of the invention. The portable communication device can be based on another type of device though, like a cordless phone, a PDA or any other type of portable device communicating with radio waves.

[0029] Fig. 1 schematically shows a front view of a cellular phone 10, which is a main unit of the portable communication device according to the invention. The phone 10 includes a keypad 12 and a display 14. The phone is furthermore provided with an electrical interface to auxiliary units in the form of a system connector 16 to which a first auxiliary unit in the form of an ear phone 18 is connected. The ear phone 18 can be provided in a portable hands free device and then be combined with a microphone. The ear phone 18 is connected to the system connector 16 via a cord. To the system connector 16 there is also connected a second auxiliary unit in the form of a charger 20 for powering a battery of the phone 10. The charger 20 is here depicted as being connected to the phone via a cord. It can however also be connected to it in some other way via for instance a desk stand, which desk stand would then be directly connected to the system connector 16.

[0030] In fig. 2 there is shown a side view of a circuit board 22 inside the phone 10, which includes some of the elements of the present invention. On one side of the circuit board 22 there is provided a battery 24. This battery 24 powers the different electrical circuits and components in the phone 10. Above the battery on a distance d there is provided a loop antenna element 26, which is connected to the circuit board via interconnecting connectors 28. The loop antenna element 26 is provided a distance d above the circuit board, which is at least 5 mm. Generally speaking, the higher above the board the loop antenna element 26 can be placed, the better it is. However, often the size limitations of the phone puts a limit to the distance. On the opposite side of the board there is provided a radio circuit 30 for reception of radio signals. The radio circuit 30 can be provided in an ASIC circuit which combines a number of functions, like for instance mobile cellular radio communication functions as well as FM radio reception functions. The board 22 also functions as a ground plane for the antenna. One end of the loop antenna element 26 is connected to the radio circuit 30 via a tuning network and another is connected to ground 23.

[0031] Fig. 3 schematically discloses the loop antenna element 26 and the battery 24 provided on the circuit board 22. Also the system connector 16 is displayed.

Here it can be seen that the loop antenna element 26 is in the shape of a rectangle that encircles the battery 24. The loop antenna element 26 preferably has a circular cross section with an area in the range of 0.1 - 10 mm². The cross-section has furthermore preferably a diameter of about 1 mm. It should however be realised that it can have other shapes, like having a rectangular cross section, and other diameters. The loop antenna element 26 is also preferably distanced from the battery 24 with about 1 mm. The positioning of the feeding point of the loop antenna element is not limited to any of the two positions indicated in fig. 3, but can be placed anywhere along the loop.

[0032] Fig. 4 shows a block schematic of a number of circuits connected to the loop antenna element 26. The feeding end of the loop antenna element 26 is connected to a notch filter 31. The notch filter 31 comprises an inductor 33 in parallel with a first capacitor 35, the function of the notch filter 31 will be described later. The notch filter 31 is connected to a tuning network 32 that is based on a CC circuit having a second capacitor 34 connected to a third capacitor 36. One end of the second capacitor 36 is here connected to ground 22, while the other end is connected to the second capacitor 34 and to an amplifier 38. The amplifier 38 is in turn connected to an impedance matching circuit 40 comprising a capacitor 42. The impedance matching circuit 40 is furthermore connected to the radio circuit 30. The radio circuit 30 is connected to an ASIC circuit (not shown) providing demodulation and sound and is also connected to the system connector 16 via ground 22. The system connector 16 has three terminals 46, 48, 50, where a first 46 is connected to ground and a second and a third 48 and 50 are intended to be connected to conductors provided in the cord of the ear phone for providing sound from the ASIC circuit. The system connector 16 further comprises a fourth and a fifth terminal 52 and 54 that lead to the battery 24 via two conductors. These terminals 52 and 54 are intended to get connected to a charger for allowing charging of the battery 24.

[0033] In normal operation of the phone for use of receiving of radio station signals, the loop antenna element is set to a radio station broadcast frequency range or frequency band by the tuning network. This tuning network can also be set to be tuned to different transmission frequencies within the band. This network can be fixed to the FM band, which is 88 - 108 MHz, but it is also possible to let it be variable for instance by using a variable capacitance in the CC circuit for allowing other radio transmission frequencies. It is also possible to set the antenna for reception of the specific frequencies used by the radio stations. This is done by influencing the tuning network, which can be controlled via the radio circuit. The received signals are then amplified by the amplifier before being provided to the radio circuit, which can then emit the sound either in a speaker in the device or in the ear phone. Because of this there is no need for the loop antenna element to have a size that is half of a wave-

length of the transmission wavelength, which allows the size reduction of the antenna element so that it fits into the portable communication device. For best performance of the loop antenna element, there is always provided air between the loop antenna element and ground, although at times some other elements might stretch into this area between loop antenna element and ground. The notch filter has the function of degrading the matching of the tuning network at a certain frequency, which frequency is preferably the frequency of another antenna in the phone provided for transmitting radio signals, like voice communication signals according to a cellular phone communication standard, for instance GSM. In this way it is ensured that such radio communication does not influence the FM radio reception too much.

[0034] The loop antenna element functions as a magnetic dipole antenna. This type of antenna is not as sensitive to changes in the surrounding area, like changes in the size of the ground plane or changes because of objects being close to the antenna element, like the body of the user of the phone. An electric dipole is on the other hand much sensitive to these changes of the surrounding area. There is yet another advantage of the antenna solution and that is that it is possible to have a charger and ear phone connected to the system connector at the same time, which is not possible when the cord of the ear phone is used as an antenna. With this prior solution, the connection between the battery and the charger would short circuit the antenna, and no reception would be possible.

[0035] As mentioned above, electric dipole antennas are sensitive to changes of the ground plane used. However the magnetic dipole antenna is not. This means that a connection of an ear phone and/or of a charger either via a cord or a desk stand to the phone, which has the consequence of enlarging the ground plane, does not negatively influence the efficiency of the loop antenna element. In fact an enlarged ground plane even enhances the antenna efficiency. There is furthermore no need to match any accessories that are connected to the system connector, which is otherwise needed when the accessory is used as antenna. This means that radio reception is better when the phone is connected to a desk stand, a charger or an ear phone via a cord. The antenna is furthermore cheap to produce, occupies little space, can be very thin and does not increase the thickness of the phone. It is furthermore possible to provide the present loop antenna element round the battery, which is a placing that an electrical dipole antenna cannot have.

[0036] The present invention can be varied in many ways. It is possible to have the loop antenna element have several other types of shapes including being of meandering shape. The loop antenna element can furthermore be provided as a thread, a trace etched onto a flex film be moulded or be of pressed metal. It can also be provided on the inside of the battery cover that is normally used for the battery. It can also be provided as a pattern in the chassis of the phone. The invention was

furthermore described in relation to the FM band, It is possible also to apply the present invention to other radio frequency bands, like VHF. The radio circuit need not be provided on the opposite side of the circuit board compared with the loop antenna element. It can just as well be provided on the same side. In fact the radio circuit can be placed anywhere on the circuit board. The tuning network is not limited to the tuning network described, It can have more or fewer components and also for instance include a capacitor the capacitance of which can be varied. The tuning network can apart from being a CC network also be an LC network or any suitable tuning network. The Impedance matching network can furthermore be omitted. It is furthermore possible to have other elements than the battery inside the loop. The portable communication device can be provided as only the main unit, which is here a phone, or both the main unit and at least one additional unit, like the ear phone and/or the charger. An auxiliary unit can furthermore be connected to one or more of the terminals of the system connector, but preferably always to the ground potential. The electrical interface described above does not have to be provided in the form of a system connector. Electrical interfaces can just as well be provided as a separate charger connection and ear phone jack, These electrical interfaces do furthermore not have to be provided at the bottom of the phone, but can be provided elsewhere on the phone.

[0037] The invention is therefore only to be limited by the accompanying claims.

Claims

1. Portable communication device comprising:

a main unit (10) comprising:

a radio circuit (30) for connection to an antenna element,
a ground plane (22),
a loop antenna element (26) connected to the radio circuit and the ground plane, and
a tuning network (32) between the radio circuit and the loop antenna element,

wherein the loop antenna element is provided at a distance (d) from the ground plane.

2. Device according to claim 1, wherein the tuning network is arranged to tune the antenna to a radio station broadcast frequency range.

3. Device according to claim 2, wherein the frequency range is the range of 88 to 108 MHz.

4. Portable communication device according to any previous claim, further comprising an electrical interface (16) to auxiliary units (18, 20), wherein the elec-

trical Interface has a connection (46) to the ground plane.

5. Portable communication device according to claim 4, further comprising at least one auxiliary unit (18, 20) connectable to at least the connection to the ground plane of the electrical interface.

6. Portable communication device according to any previous claim, wherein at least one element (24) of the device is provided Inside the loop of the loop antenna element.

7. Portable communication device according to any previous claim, wherein the loop antenna element has an essentially rectangular shape.

8. Portable communication device according to any previous claim, wherein the distance between the loop antenna element and the ground plane is at least about 5 mm.

9. Portable communication device according to any previous claim, wherein the cross section of the loop antenna element has an area in the range of 0.1 - 10 mm².

10. Portable communication device according to claim 9, wherein the cross-section of the loop antenna element has a diameter of approximately 1 mm.

11. Portable communication device according to any previous claim, further comprising a notch filter (31) connected between the loop antenna element and the tuning network.

12. Portable communication device according to any previous claim, in which it is a cellular phone.

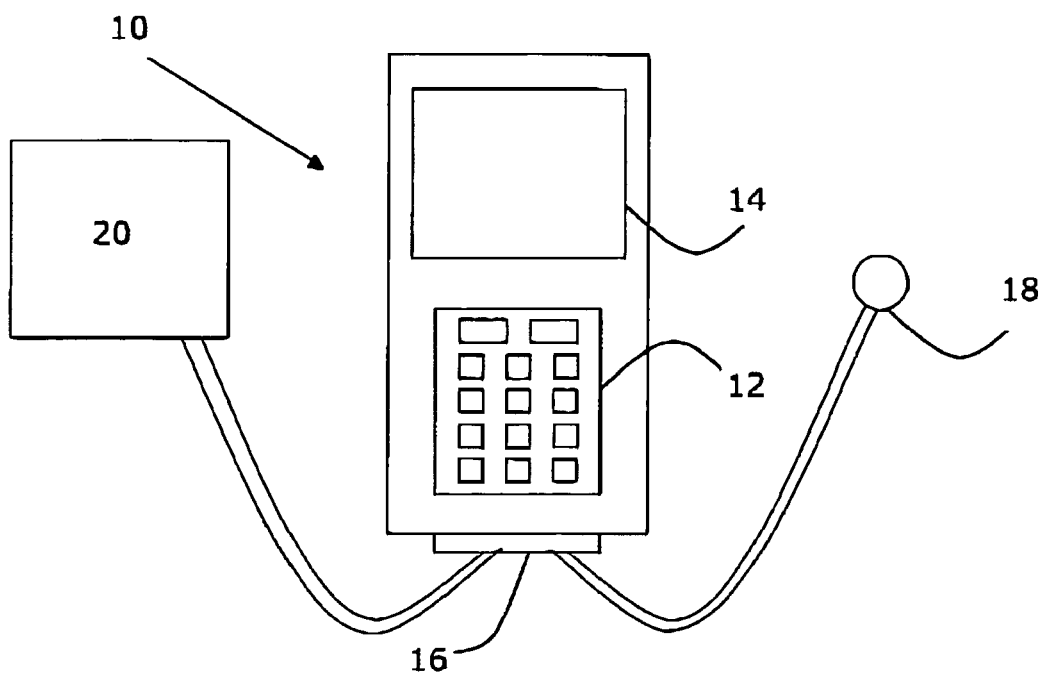


FIG. 1

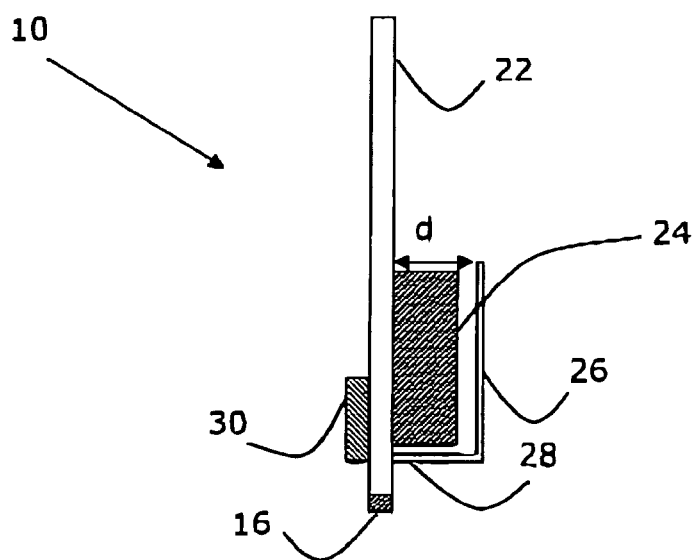
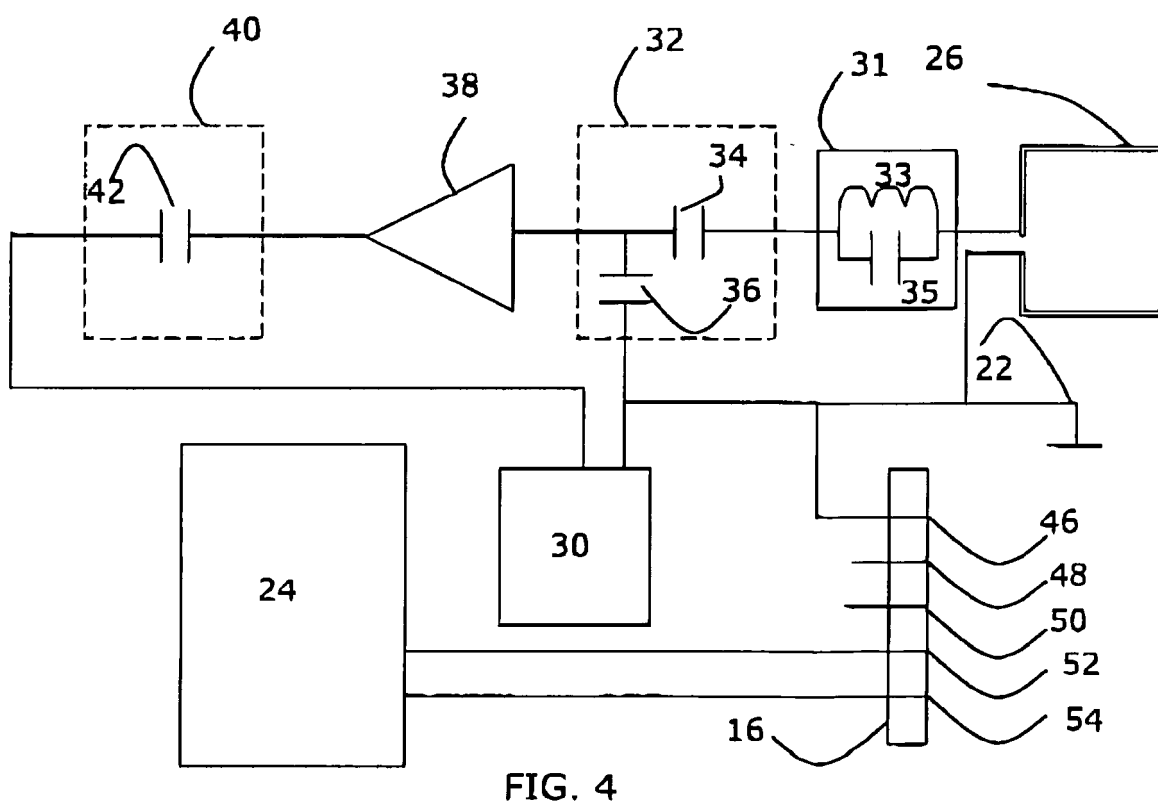
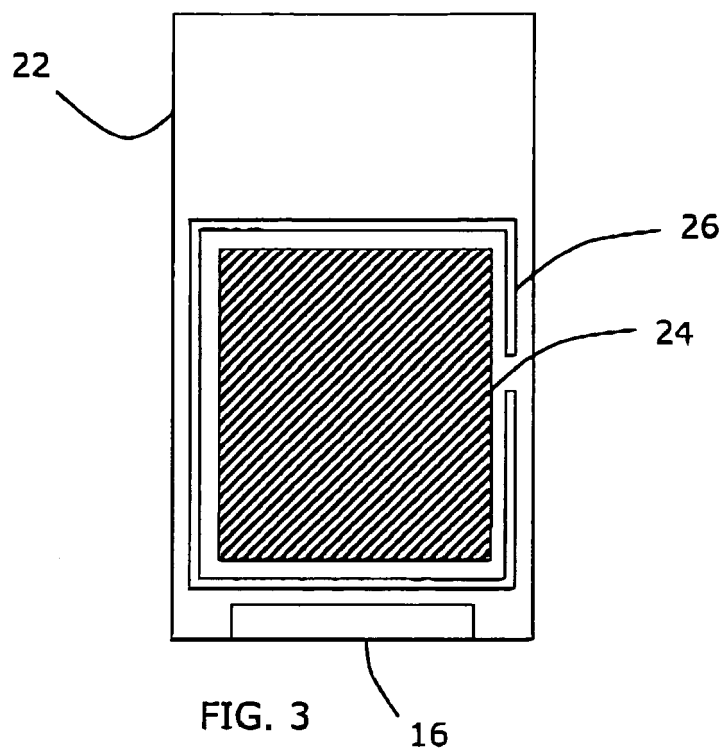


FIG. 2





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 00 2488

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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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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EPO FORM 1503 03.02 (P04C01)

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