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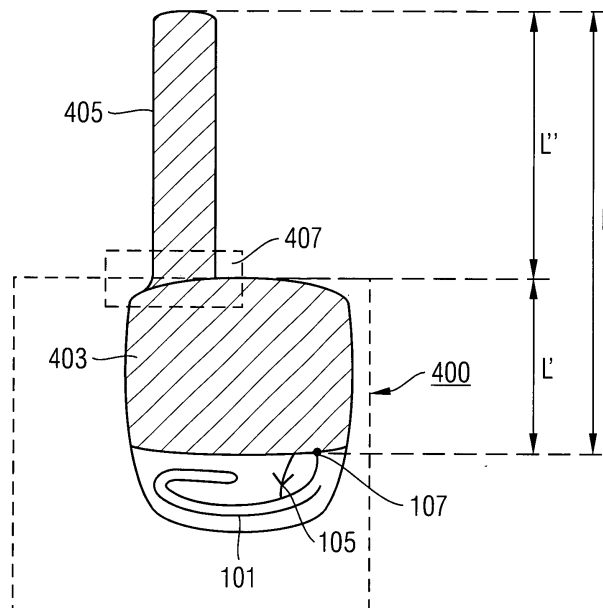
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(54) **An extension for an antenna ground plate, an antenna ground plate, an antenna, and devices using the same**

(57) An extension (405) for a ground plate (403) for an antenna element (101), especially a FIFA or a micro-strip antenna element, and preferably designed to be used for at least one mobile communications frequency band, and for improving the performance of an antenna

on at least one of said frequency bands, together with the ground plate (405) has an electrical length (L) which is optimized to produce a reflection coefficient close or at a minimum reflection coefficient (S11) for a pre-defined frequency band, especially for the GSM 900 MHz band or GSM 850 band.

FIG 4



Description

Field of the invention

[0001] The invention relates to construction of antennas and, more specifically, to extending of a ground plate for an antenna.

Background for the invention

[0002] The still growing popularity of mobile communications has increased the need to design new handsets and mobile terminals. Also other devices, such as different household gadgets, are currently being integrated into the world of mobile communications.

[0003] One of the most important parts in a device intended for communications is the antenna. In order to communicate with other devices or with any communications infrastructure, such as a mobile network, the antenna need have operating characteristics meeting strict requirements, such as those relating to resonant frequency, bandwidth, and gain.

[0004] For example, in the GSM standards, the most traditional 900 MHz frequency band extends from 880 to 960 MHz. For CT1+ indoor cordless telephones the frequency range is even larger, extending from 886 to 931 MHz. Most network operators have taken some other frequency bands in use so that most state-of-the-art devices are now supposed to have at least dual band characteristics, the second band being commonly around 1800 MHz.

[0005] Antenna design would not be too big a problem if the evolution of the communications networks were taken alone. However, the device miniaturization led by top designers has turned out to be a necessary step towards getting a good market position, especially in the consumer market. The device miniaturization has been very strong for handheld devices, such as mobile terminals like mobile phones. Further, there are new kinds of communication devices entering the market in the foreseeable future.

[0006] In the past, the most commonly used whip (monopole) antennas and other external antennas, such as normal mode helix or meander line antennas, could be used without any greater problem. Unfortunately, this kind of antenna structures are not suitable any more for present devices because of the recent developments. It is mostly a trend that the antenna should be internal and thus also invisible to the user.

[0007] Figure 1 shows an example of a modern structure for an internal antenna 100, such as the Folded Inverted-F Antenna FIFA or the microstrip patch antenna. Such a structure is very suitable for relatively small mobile devices. These structures are used in most mobile phones available on the market at the time of writing. They provide many benefits simply by being small, lightweight, efficient, and relatively flat. Further, they apt well for mass production because they can be implemented

as printed circuit antennas. The shape of the copper strip defines the resonance frequencies. Such a copper strip as schematically illustrated in Figure 1 has two resonances on 900 MHz and 1800 MHz.

[0008] The antenna element (i.e. transducer) 101 of a FIFA or microstrip patch antenna has a size very small compared to the wavelength. The conductor strip as antenna element 101 is attached by connector 107 (which is also a short point) to the ground plate 103, such as to a printed circuit board PCB. The feed line 105 brings the actual signal to be transmitted to the antenna element 101.

[0009] As one of the consequences of the small size, the antenna element 101 has a very high-Q value meaning that the resulting bandwidth is extremely narrow. In order to cope with the requirements defined in different communications standards, the bandwidth must be broader.

[0010] Figure 2 shows a known principle how this can be done, as ingeniously disclosed by several authors, such as by Vainikainen *et al.* in "Effect of Phone Chassis on Handset Antenna Performance" (Report S240, HUT Radio Laboratory Publications, Espoo, March 2000), by coupling the antenna element to a ground plate. The antenna element 101 of Figure 1 is now the first monopole 201 of a dipole antenna 200, whereas the ground plate 103 works as the other monopole 203 of the same dipole antenna 200. The ground plate 103 is very big compared to the wavelength and has then a low-Q value, so that the resulting combination antenna 100 has a larger bandwidth.

[0011] During the ongoing miniaturization, the size of a mobile device wherein the antenna should be used is getting very small. This is going to lead to further challenges in the field of antenna design, because, in response to a very small size of the ground plate, the bandwidth requirements cannot be met any more for the lower frequencies, such as for the 900 MHz band.

[0012] Even though in the patent literature there are some antenna solutions for small devices, like those proposed in US patents 6,212,414; 6,366,250; and published patent applications WO 2001/91229, and EP 0 288 676, all these solutions seem to concentrate on other possible drawbacks which are brought about when a mobile terminal is constructed into a small carryable device.

[0013] EP 0 288 676 has a loop antenna; the problems related to loop antennas are different from the antennas regularly used for GSM frequencies. The antenna, being the coupling element, is housed inside the strap.

[0014] US 6,366,250 discloses a conductive shielding in a wrist strap for a sort of dipole antenna. The purpose of the shielding is to shield the user from the electrical field generated by the antenna. This is done in order to improve reception by minimizing the relative load of the wrist of the user; otherwise this load would reduce the sensitivity of the antenna. The shieldings may however

disturb the antenna performance significantly. Also WO 2001/91229 has a much similar shielding.

[0015] The wristwatch device of US 6,212,414 has all device transmitter and receiver electronics in the wrist strap. Therefore, the candidate user will be mesmerized by its size. Further, the performance of spring-retractable antenna system of '414 may be questionable.

Short description of the invention

[0016] It is a main objective of the invention to enable the use of a lower frequency band for a device having a very small size compared to the wavelength of the band. This and other objectives of the invention can be achieved with a method and a system according to any one of the independent patent claims.

[0017] An extension for a ground plate enables the use of a smaller ground plate. Preferably, the ground plate is the ground plate for an antenna element, such as a FIPA or a microstrip antenna element. These are the most typical kinds of antenna elements where the problems of prior art solutions would be encountered, because the antenna elements are pretty high-Q and therefore depend much on the size and quality of the ground plate.

[0018] The antenna element can be designed to be used for at least one mobile communications frequency band, thus allowing a dual- or multi-band capabilities. Then the extension is designed to improve the performance of the antenna on at least one of said frequency bands.

[0019] The electrical length of the extension together with the ground plate can be optimized to produce a reflection coefficient close or at a minimum reflection coefficient for a predefined frequency band, especially for the GSM 900 MHz or the GSM 850 band (which is widely used in the US, 824 MHz to 894 MHz). This enables the use of a very small chassis providing too small a ground plate for the antenna element selected.

[0020] The extension can further include connecting means adapted to connect said extension for a ground plate to said ground plate. This makes the assembling step more easy. Further, if performed by an end-user, the user can conveniently join the extension to the ground plate.

[0021] The extension may further comprise releasing means, such as a release switch, adapted to detach said extension from said ground plate. This allows the user to change the physical size of his/her mobile device, and whenever necessary, plug in the extension for better radio coverage etc. on the band for which the extension has been designed.

[0022] According to one aspect of the present invention, the extension can be within, on, and/or around carrying means, such as a neck strap or wrist strap. This is very practical, because then the user does not need to remember the extension but it is automatically carried with. Further, the extension can comprise power supply

means, such as a rechargeable battery. Especially when a Lithium-Ion-battery is used as the rechargeable battery, the rechargeable battery itself can work as the extension. This is very favourable because there is then no need for an extra component.

[0023] According to one aspect of the present invention, the extension can be within or connected to a desk-top stand. An advantage of such a solution is that it cures the degradation of the radio capabilities caused by removing a previous extension if the previous extension is normally located in such a part that has to be removed before the device is placed to the desktop stand. According to one further aspect of the present invention, the extension can be within or connected to any accessory for the mobile terminal.

[0024] According to one further aspect of the present invention, the desktop stand further includes an isolator circuitry between a charger and the desktop stand. Said isolator circuitry can comprise at least two coils, for example. The advantage of such a solution is that it recovers the degradation of the radio capabilities because the effect of the extension of the ground plate size seen by the antenna element would be distorted because the charger wire would also couple to the antenna element.

[0025] A ground plate is to be used together with an extension. The ground plate is preferably without the extension shorter than a wavelength of one of the bands for which the antenna element coupling with the ground plate is designed. In this manner, the size of the ground plate can be reduced thus enabling the further miniaturization of the mobile terminal and giving better radio capabilities also for radio bands with frequencies having a longer wavelength than the dimensions of the ground plate.

[0026] The invention as described is especially suitable for small-sized mobile devices, such as pendant phones and/or wrist phones.

Brief description of the drawings

[0027] In the following, the invention and its preferred embodiments are described more closely referring to the examples shown in Figures 3 to 10B in the appended drawings, wherein:

Figure 1 illustrates a state-of-the-art antenna part of a mobile device 100;

Figure 2 is a schematic picture of a dipole antenna;

Figure 3 shows results of simulations of the effect of the length of the ground plate of an antenna on the bandwidth obtained;

Figure 4 shows one embodiment of an extension for a ground plate;

- Figure 5A shows a further zoomed view of the connecting part 407;
- Figure 5B & 5C illustrate the extension side connecting means in more detail;
- Figure 6 shows a use case of the present invention;
- Figure 7 shows one further embodiment of the present invention applied to a device carried on or around user's wrist;
- Figure 8 shows one further embodiment of the present invention applied to a tabletop stand; one charging-related aspect of the invention is also shown;
- Figure 9 shows a possible structure for the isolating circuitry 805; and
- Figure 10A & B show how the coil 905 in the isolating circuit 901A, 901B of Figure 9 can be selected.

[0028] Like reference signs refer to corresponding parts and elements throughout Figures 1-10B.

Detailed description of the invention

[0029] Figure 3 shows results of simulations of the effect the length of the ground plate of an antenna on the bandwidth obtained. The high-Q coupling element 101 is fixed, and the electrical length L of the ground plate 103 is changed. The coupling element 101 corresponds to such typically used for GSM 900 band, and can be as shown in Figure 1, where the coupling element 101 is in itself a low-Q coupling element for also GSM 1800 band.

[0030] The results of the measurements show that the bandwidth BW is at maximum BW_{max} when the electrical length L of the ground plate 103 is about 14 cm. The bandwidth BW is relatively close to the maximum BW_{max} also when the electrical length L of the the ground plate 103 is within a length range $[14\text{ cm} - \Delta L_-, 14\text{ cm} + \Delta L_+]$, where ΔL_- and ΔL_+ are both some millimeters. Usually, the optimal length L of the ground plate is a bit shorter due to the effect of the dielectric housing of a mobile device wherein the antenna is used. The exact magnitude of this effect depends on the dielectric, so usually a length L around 13 cm is optimal, so the ΔL_+ is shorter than ΔL_- . In our simulation results, the range from 130 to 145 mm would be the optimal range for the length L of ground plate 103, giving 90 MHz Bandwidth. For GSM 900 one needs a bandwidth of 80 MHz minimum, so then the acceptable range for the length of the ground plate 103 would be from a bit more than 120 mm to

around 150 mm.

[0031] Figure 4 shows one of the ideas behind the invention: the main problem with the poor performance of the antenna of a mobile terminal 400 lies in the fact that the electrical length L' of the ground plate 403 would now be too small. In the new Siemens K2, for example, the printed circuit board is around 6 cm; as seen from Figure 3, the resulting bandwidth would then be relatively small. Therefore, an extension 405 for the ground plate 405 is required. The extension 405 connected by using connecting part 407 acts together with the ground plate 403 as a bigger ground plate for the antenna element 101, which like in Figure 1 is connected by using a connector 107 to the ground plate and fed at the feed line 105. The electrical length L" of the extension 405 is selected to give $L' + L'' = L$, where L is an optimal electrical length of the ground plate for the antenna element 101. Therefore the resulting bandwidth is close to BW_{max} obtainable for the antenna element 101.

[0032] In particular, for this case, a solution such as those proposed in prior art patent documents cited above is not possible, because i) all transmitter/receiver electronics cannot be placed into a (wrist) strap: the strap has to be relatively thin and look nice, and ii) it is preferred that a carrying strap can be replaced or at least removed. To the latter point there are several reasons, namely that the charging connector will be placed to same place as the connection means in order to avoid the need to build a multiple openings to the housing of the mobile terminal 400. Further, if for some reason the carrying strap would be damaged, the expected users would definitely not like the idea that they should buy a completely new device. This would be the case when the electronics were built into the strap. If the electronics are not built into the strap, a person skilled in the art has now a serious problem. The shielding examples known from state of the art are of no help either.

[0033] Figure 5A shows a zoomed view of the connecting part 407. The ground plate, say the PCB, has terminal side connecting means 407A which are matched to fit together with extension side connecting means 407B. In the most simplest case, the terminal side connecting means 407A comprise only a connector socket 501. The connector socket 501 is electrically connected to the ground plate 403.

[0034] The extension side connecting means 407B comprise at least a connector 503. The connector 503 is electrically connected to the extension 405 of the ground plate 403. The extension 405 is preferably covered by cover 504.

[0035] The extension side may optionally comprise also communication wires 505 which are through connector 503 and connector socket 501 connected to corresponding circuitry on the PCB in practice on another layer of the PCB than the ground plate 403. The communication wires 505 may also be covered by cover 506. A possible purpose of the communication wires 505 is to enable a hands-free use of the terminal 400, and

therefore they may be further connected to a headset including a loudspeaker (bone conductor, for example) and microphone.

[0036] Figure 5B illustrates the extension side connecting means 407B in more detail. In our example, the extension 405 is implemented using wires 405 that are fixed to the connector 503. The extension 405 continues then inside the strap under cover 504 and may be implemented using wires, or a plate- or strip-like structure.

[0037] The communication wires 505 run on other side of the connector 503. By using such an approach the isolation between the communication wires 505 and the extension 405 can be enhanced because, as already noted, the ground plate 403 is conventionally, in a different layer of the PCB as the circuitry.

[0038] Further, the release switch 509, such as a press-button can be used to detach the extension side 407B from the terminal side 407A.

[0039] Figure 5C shows the extension side 407B from another angle. Here one can better see the release switch 509 which is operationally connected to lock pin 513. The lock pin 513 locks the extension side 407B to the terminal side 407A. The guide pin 511 is intended for helping the user to attach the extension side 407B in a right manner to the terminal side 407A.

[0040] Figure 6 shows a use case of one embodiment of the present invention. The mobile terminal 400 is carried on carrying means 600 comprising a neck strap 601 and extension 405 of the ground plate 403. The extension 405 may be hidden inside the neck strap 601 as well. The user is very satisfied because despite of the extremely small size of the mobile terminal the performance of the radio part is excellent because of the extension 405 of the ground plate.

[0041] Communication wires 505 are inside the neck strap 601 in the other branch of the neck strap 601 than the extension 405 in order to reduce distortions. Otherwise it could be very hard to decouple the communication wires 505 from the extension 405.

[0042] Figure 7 shows one further embodiment of the present invention applied to a device carried on or around user's wrist. In this case, the electronics is included in the mobile terminal 400; the extension 405 of the ground plate 403 is again hidden inside the carrying means 600.

[0043] Figure 8 shows one further embodiment of the present invention applied to a tabletop stand. The table stand includes an extension 405 for the ground plate 403. A small-sized radio device which normally has an extension 405, for example, in the carrying means 600, loses a significant part of its bandwidth, especially on 900 MHz band, when the carrying means are removed. The reason behind this is that the electrical length L of the ground plate 403 changes then drastically. This enables a construction in which the charger connector is placed on the same opening of the housing as the extension connector socket 501. Further it enables that the carrying means 600 can be removed when the mobile

terminal 400 is in a tabletop stand; this results in optically more appealing design.

[0044] The solution for the problem is to include an extension 405 to the tabletop stand.

5 **[0045]** However, the antenna element 101 could see the charger wire 802 as a longer ground plate when charger 801 is attached. In other words, the transformer line will disturb the extension because it is longer so that the electrical length the antenna element sees changes.

10 **[0046]** For a normal sized mobile terminal the degradation of the antenna quality is not a problem so no filtering or isolating is necessary. It is somehow acceptable that the antenna performance degrades while the terminal is being charged. However, for a very small mobile device the length is too short to enable a proper performance. Then in some cases the performance of the extension of the ground plate can not be good enough to

15 **[0047]** This problem can be avoided by using an extra component, namely isolator circuitry 805. The impedance of the component is selected to be very high at the desired bandwidth of the extension. This can be done by using an isolator having filter characteristics. The isolator can be constructed by using selected components, especially coils, which have a resonance frequency at
20 900 MHz. The isolator does not allow the radio signal to pass into the charger line. A coil is ideal for isolator because it lets Direct Current almost completely and unattenuated through.

25 **[0048]** So there is now an isolator circuitry 805 between the extension side connecting means 407B and the charger wire 802. The isolator circuitry 805 works also in the other direction so that the mobile terminal 400 does not cause disturbances in the mains network when the mains plug 803 is connected.

30 **[0049]** Figure 9 shows a possible structure of the inventive isolator circuitry 805. The isolator circuitry 805 includes preferably two isolating circuits 901A, 901B which isolate leads 904A, B to charger 801 from leads 903A, B to mobile terminal 400 or desktop stand 800, respectively.

35 **[0050]** In a coil there is normally some parasitic capacitance too. This means that in RF frequencies the coil is not purely inductive any more. The higher value of the coil, the lower the resonance frequency - i.e. isolation.
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45 **[0051]** The isolator can include also special ferrites instead or in addition to the coils. This is practical for lower frequencies of some hundred MHz. The ferrite ring is placed in a known manner around the power line, but this time between the desktop stand and the charger, or in the charger wire.

50 **[0052]** Each of the isolator circuits 901A, 901B includes preferably a coil 905. In the microwave frequencies, a coil 905 usually has some capacitance which is the reason that the isolator circuit 901B shows also a parallel capacitor 907.

55 **[0053]** Figure 10A and B show one principle according to which the coil 905 in the isolating circuit 901A,

901B of Figure 9 can be selected.

[0054] We choose a coil 905 with the first resonance frequency f_0 at 900 MHz. This can easily be done by looking the data sheet of a component catalogue. The coil 905 introduces a high impedance with a complex phase that decreases with growing frequency f . The impedance changes from being almost purely inductive at lower frequencies to almost purely capacitive at higher frequencies. At the resonance frequency the impedance is at its maximum and pure resistive. Beyond this resonance frequency f_0 the capacitor is dominating, and so on.

[0055] Figure 10B shows that the impedance $|Z|$ is at maximum at the resonance frequency f_0 . This logic can be used to check whether or not the coil 905 selected actually fits with the requirements.

[0056] According to one aspect of the invention, in one extreme the mobile terminal 400 includes only at least the coupling point as the connector socket 501 and the antenna element 101. The feeding of the antenna is then done in the mobile device, close to or on the PCB. The ground plate 403 is then located at the socket 501 and the rest of the ground plate is located in the extension 405 of the ground plate 403.

[0057] Although the invention was described above with reference to the examples shown in the appended drawings, it is obvious that the invention is not limited to these but may be modified by those skilled in the art without difference from the scope and the spirit of the invention. For example, the antenna element 101 can be any type of antenna element also other than FIFA, such as a PIFA, loop antenna, or any patch antenna.

List of used reference numbers

[0058]

100	antenna
101	antenna element
103	ground plate
105	feed line
107	connector
200	dipole antenna
201	monopole
203	monopole
400	mobile terminal
403	ground plate
405	extension of the ground plate 403
407	connecting part
407A	terminal side connecting means
407B	extension side connecting means
501	connector socket
503	connector
504	cover
505	communication wires
506	cover
509	release switch
511	guide pin

513	lock pin
600	carrying means
601	neck strap
800	desktop stand
5 801	charger
802	charger wire
803	mains plug
805	isolator circuitry
900A, B	isolator circuit
10 903A, B	leads to mobile terminal or desktop stand
904A, B	leads to charger
905	coil
907	capacitor

Claims

1. An extension (405) for a ground plate (403) for an antenna element (101).
2. An extension (405) for a ground plate (403) according to claim 1, **wherein:** the antenna element (101) is especially a FIFA or a microstrip antenna element.
3. An extension (405) for a ground plate (403) according to claim 1 or 2, **wherein:** said antenna element (101) is designed to be used for at least one mobile communications frequency band.
4. An extension (405) for a ground plate (403) according to claim 3, **wherein:** said extension (405) for a ground plate (403) is designed to improve the performance of an antenna on at least one of said frequency bands.
5. An extension (405) for a ground plate (403) according to claim 4, further **characterized in that:**

the electrical length (L) of said extension (403) together with the ground plate (405) is optimized to produce a reflection coefficient close or at a minimum reflection coefficient for a pre-defined frequency band, especially for the GSM 900 MHz band or GSM 850 band.
6. An extension (405) for a ground plate (403) according to any one of the preceding claims, further **comprising:** connecting means (4078) adapted to connect said extension (405) for a ground plate (403) to said ground plate (403) .
7. An extension (405) for a ground plate (403) according to any one of the preceding claims, further **comprising:**

releasing means (509), such as a release

switch, adapted to detach said extension (405) for a ground plate (403) from said ground plate (403).

8. An extension (405) for a ground plate (403) according to any one of the preceding claims, further **characterized in that:**

said extension is within, on, and/or around carrying means (600).

9. An extension (405) for a ground plate (403) according to claim 8, further **comprising:** power supply means, such as a rechargeable battery, within, on, and/or around said carrying means (600).

10. An extension (405) for a ground plate (403) according to claim 9, **wherein:** said power supply means are the extension (405) of the ground plate (403).

11. An extension (405) for a ground plate (403) according to claim 10, **wherein:** said power supply means include a rechargeable Lithium-Ion-battery.

12. An extension (405) for a ground plate (403) according to any one of claims 8 to 11, **wherein:** said carrying means (600) include a neck strap (601).

13. An extension (405) for a ground plate (403) according to any one of claims 8 to 11, **wherein:** said carrying means (600) include a wrist strap.

14. An extension (405) for a ground plate (403) according to any one of claims 1 to 7, **wherein:** the extension (405) for a ground plate (403) is arranged to be within or connected to a desktop stand (800) or to any accessory other than a desktop stand (800).

15. An extension (405) for a ground plate (403) according to claim 14, **wherein:** the desktop stand (800) further includes an isolator circuitry (805) between a charger (801) and the desktop stand (800).

16. An extension (405) for a ground plate (403) according to claim 15, **wherein:** said isolator circuitry (805) comprises at least two coils (905).

17. A ground plate (403) to be used together with an extension (405) for the ground plate (403) according to any one of the preceding claims.

18. A ground plate (403) according to claim 17, **including:** connecting means (407A) for electrically connecting the extension (405) for the ground plate (403) to the ground plate (403).

19. A ground plate (403) according to claim 18, further **including:** detaching means (509), especially a re-

lease switch, adapted to electrically detach the extension (405) for the ground plate (403) from the ground plate (403) .

- 5 20. A ground plate (403) according to claim 18 or 19, further **characterized in that:**

said ground plate (403) is electrically connected to an antenna element (101).

- 10 21. A ground plate (403) according to claim 20, **characterized in that:**

said antenna element (101) a FIFA or a micro-strip antenna element.

- 15 22. A ground plate (403) according to claim 20 or 21, **characterized in that:**

said ground plate (403) is without the extension (405) for the ground plate (403) shorter than a wavelength of one of the bands for which said antenna element (101) is designed.

- 20 23. An antenna including:

- a ground plate (403) according to any one of preceding claims 17 to 22; and
- an antenna element (101) electrically connected to said ground plate (403).

- 25 24. An antenna according to claim 23, further **characterized in that:**

said ground plate (403) is used together with an extension (405) for a ground plate (403) according to any one of the preceding claims 1 to 16.

- 30 25. A mobile device (400), especially a mobile phone, **comprising:** an antenna according any one of the claims 23 to 24.

- 35 26. A mobile device (400) according to claim 25, **wherein:**

said mobile device is a pendant phone.

- 40 27. A mobile device (400) according to claim 25, **wherein:**

said mobile device is a wrist phone.

- 45 28. A mobile device (400) according to claim 25, **wherein:** the mobile device (400) is a dual-, triple- or multi-band device.

29. A mobile device (400) according to claim 28, **wherein:** the performance of the mobile device without an extension according to any one of claims 1 to 17 does not fulfill requirements for type approval on at least one frequency band.

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Amended Claims under Rule 86 (2) EPC

1. An extension (405) for a ground plate (403) for an antenna element (101) of a mobile terminal (400), whereby the electrical length (L) of said extension (405) together with the ground plate (403) has been optimized to produce an antenna input reflection coefficient close to or at a minimum reflection coefficient for a predefined frequency band, **characterized in that:** the antenna element (101) and the ground plate (403) are within the mobile terminal (400), whereas the extension (405) of the ground plate (403) is within carrying means (600) of the mobile terminal (400), or in a desktop stand (800) of the mobile terminal (400).

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2. An extension (405) for a ground plate (403) according to claim 1, **wherein:** the antenna element (101) is a FIPA or a microstrip antenna element.

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3. An extension (405) for a ground plate (403) according to claim 1 or 2, **wherein:** the carrying means (600) comprises a neck strap (601).

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4. An extension (405) for a ground plate (403) according to claim 3, **wherein:** the extension (405) is formed by a rechargeable battery.

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5. An extension (405) for a ground plate (403) according to claim 1, **wherein:** the desktop stand (800) comprises an isolator circuitry (805) between a charger (801) and the desktop stand (800).

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FIG 1
Prior Art

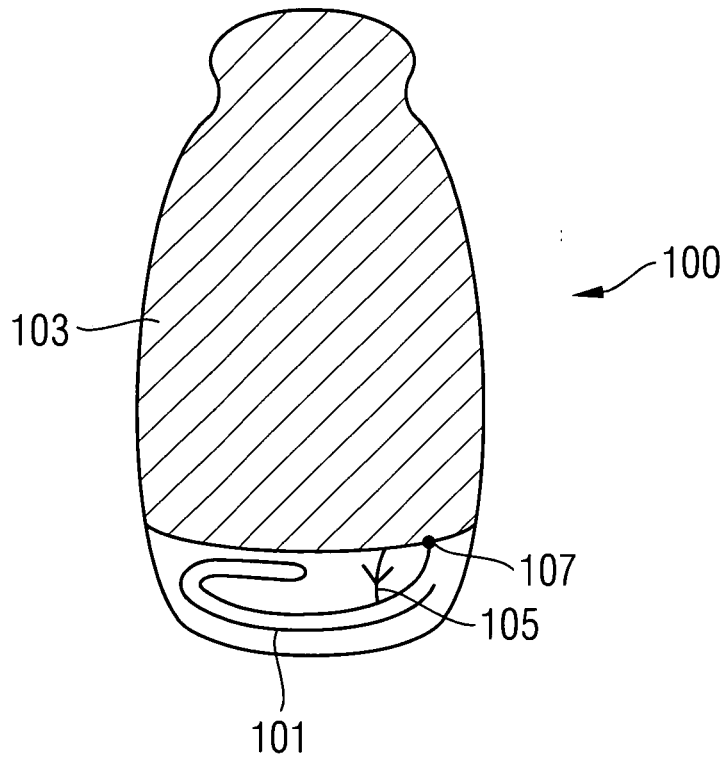


FIG 2
Prior Art

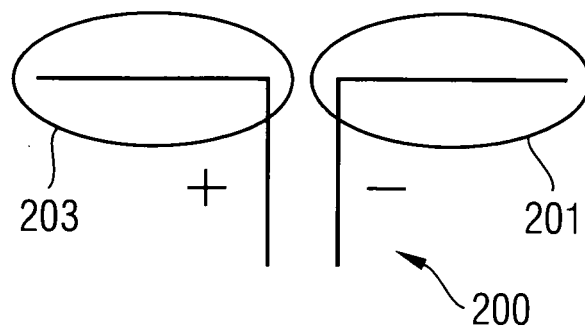


FIG 3

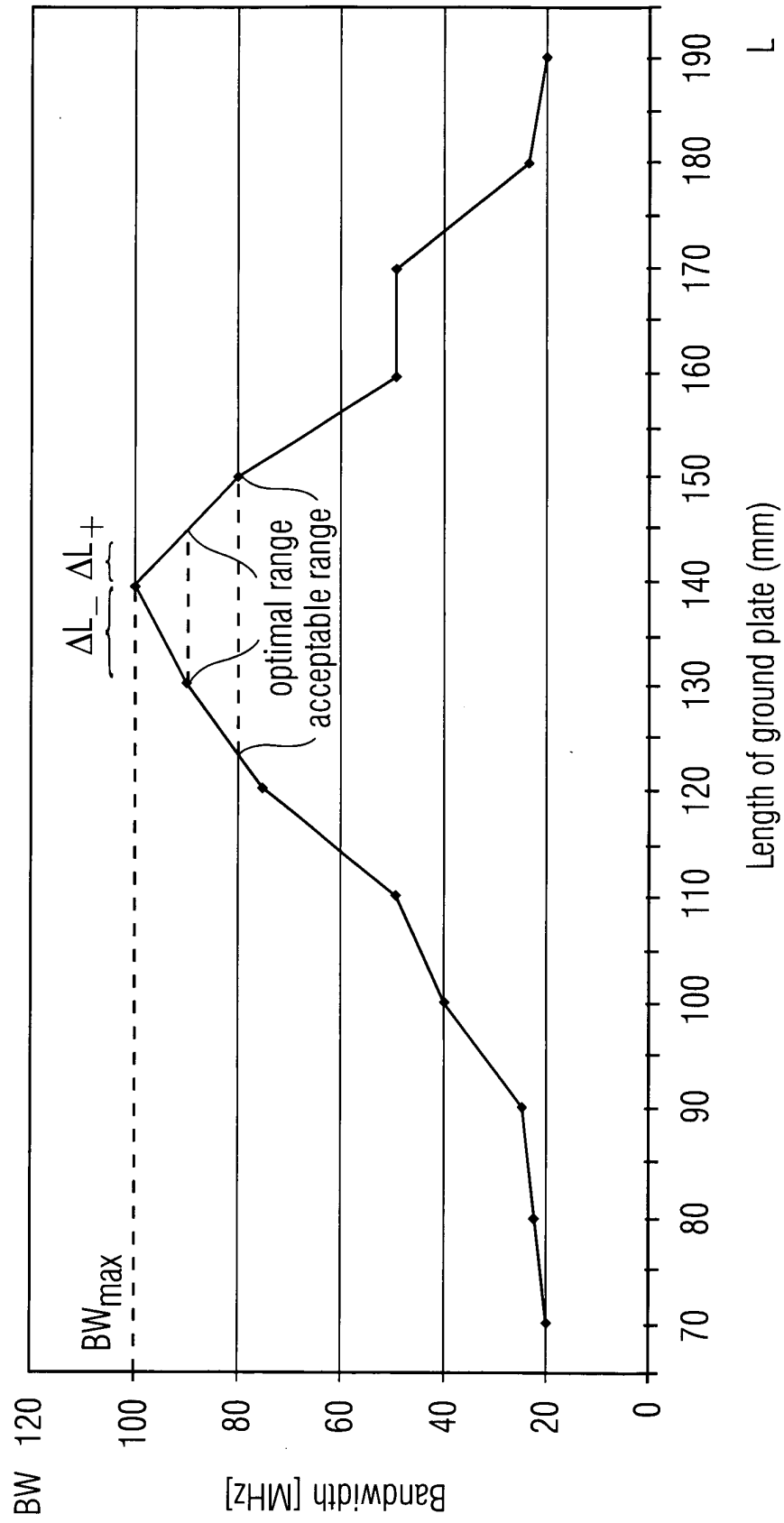


FIG 4

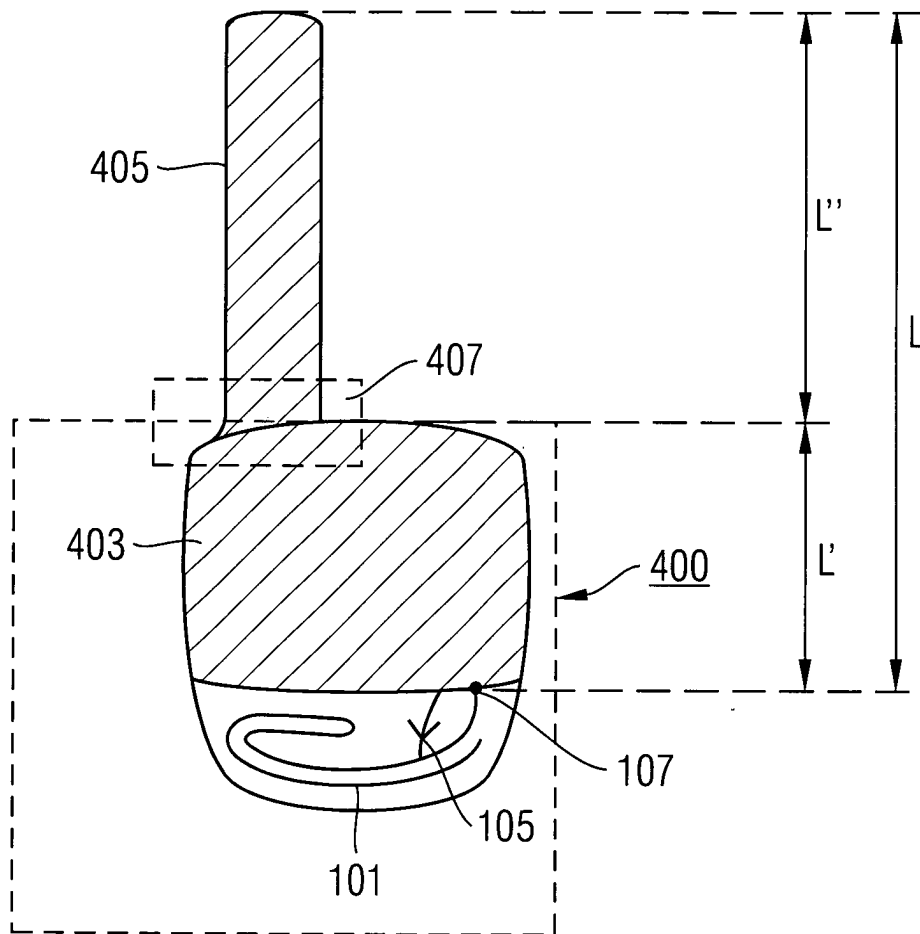


FIG 5A

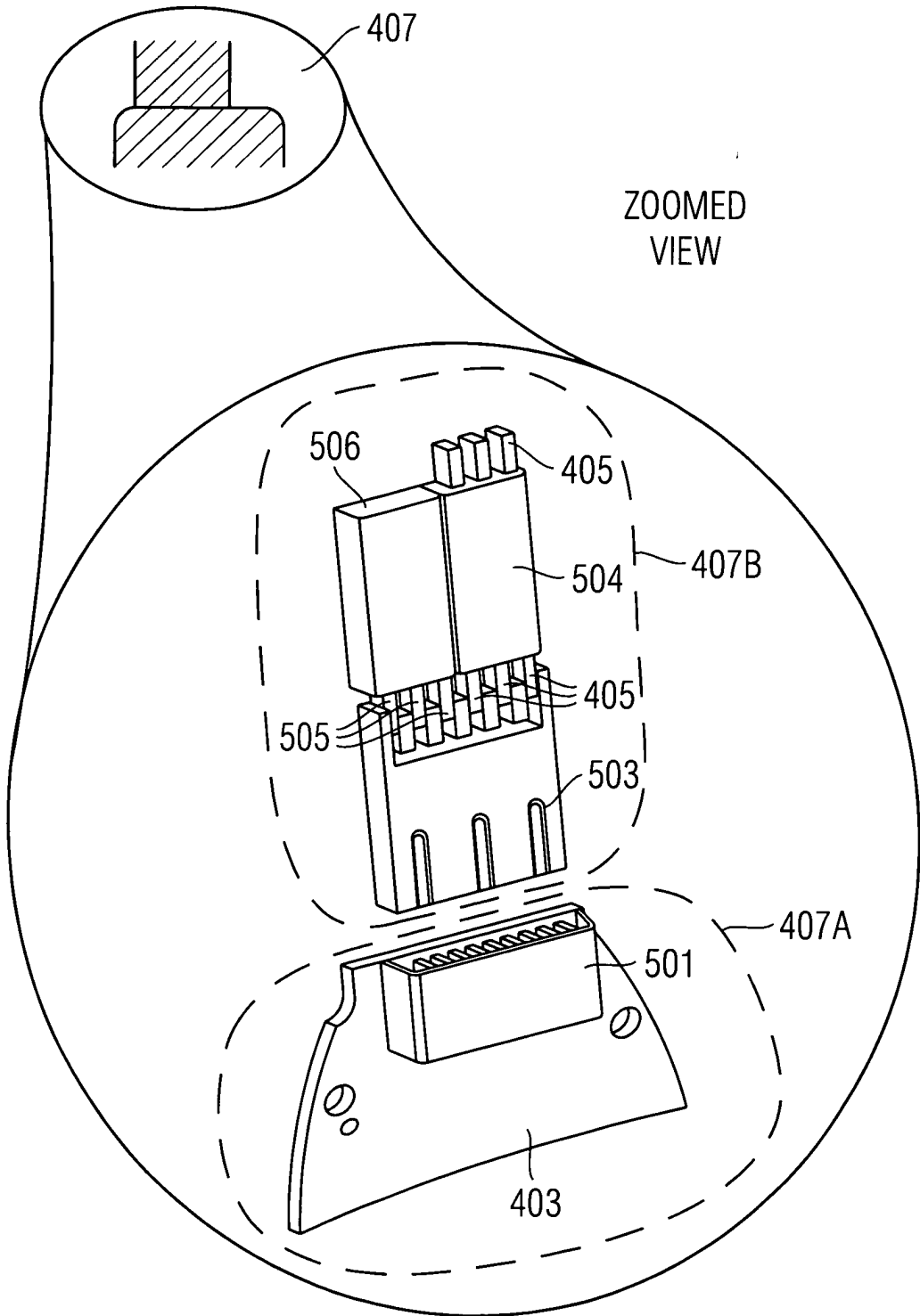


FIG 5C

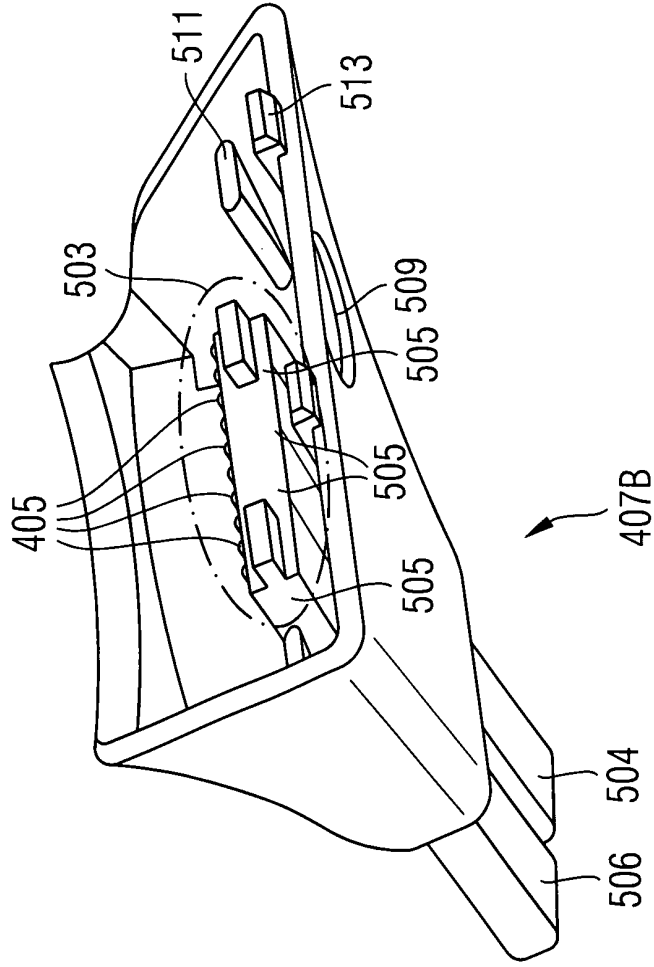


FIG 5B

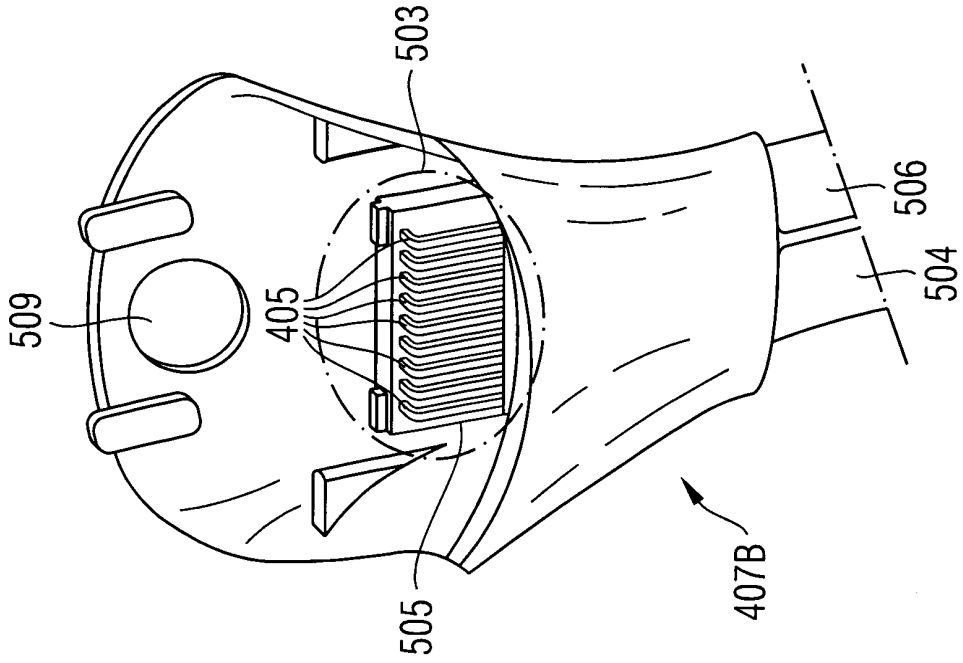


FIG 6

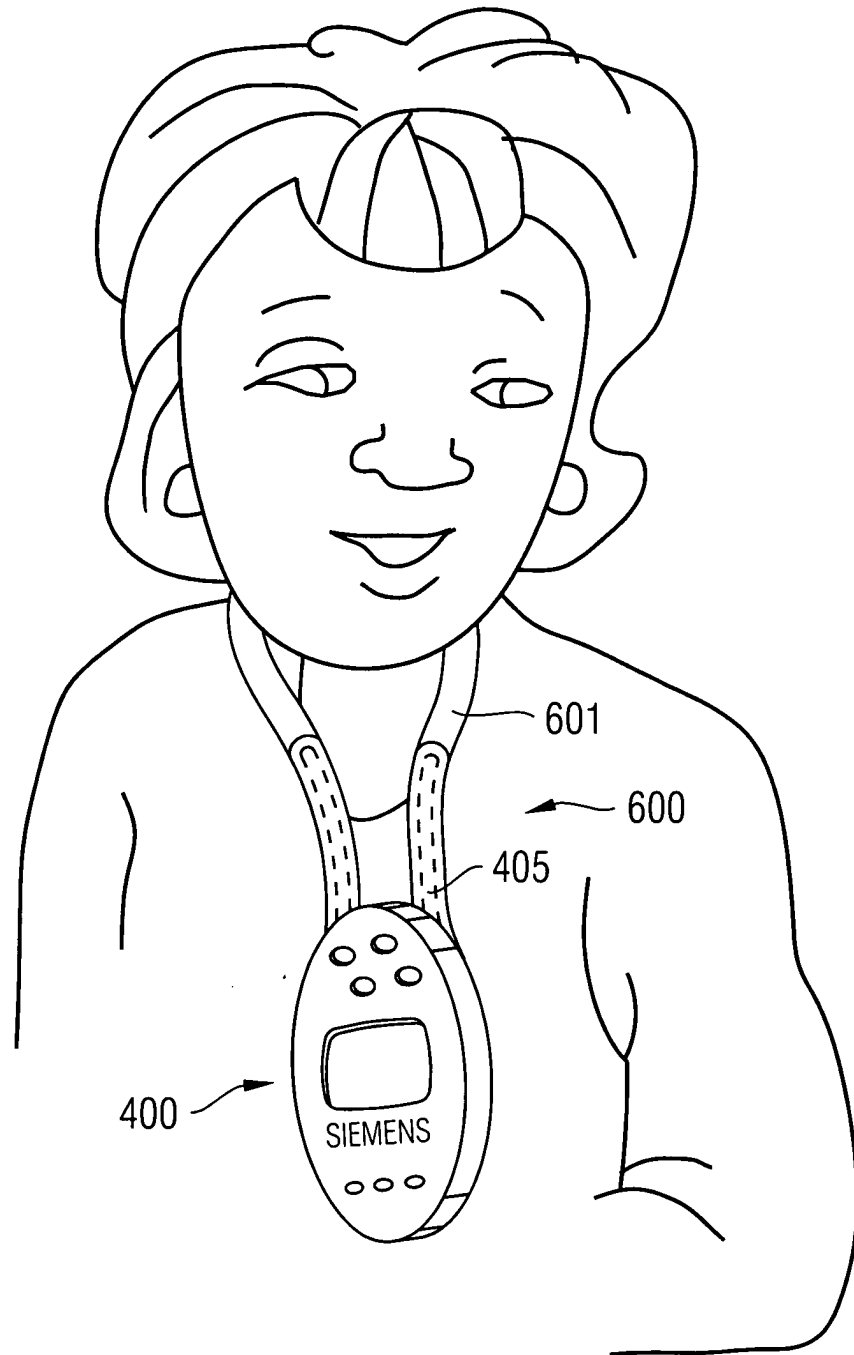


FIG 7

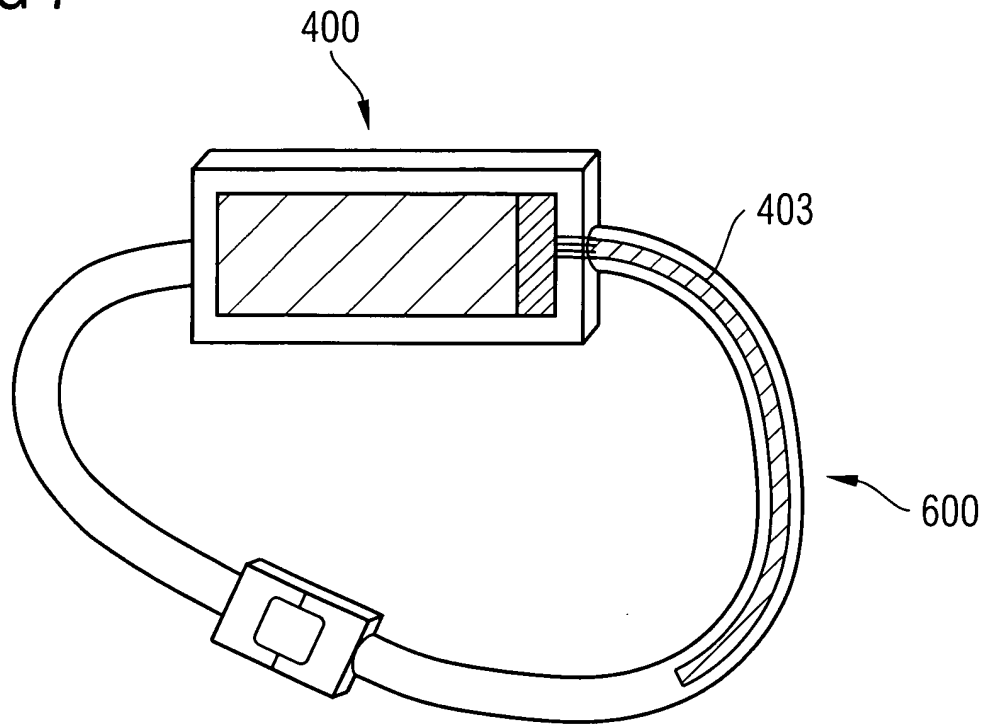


FIG 8

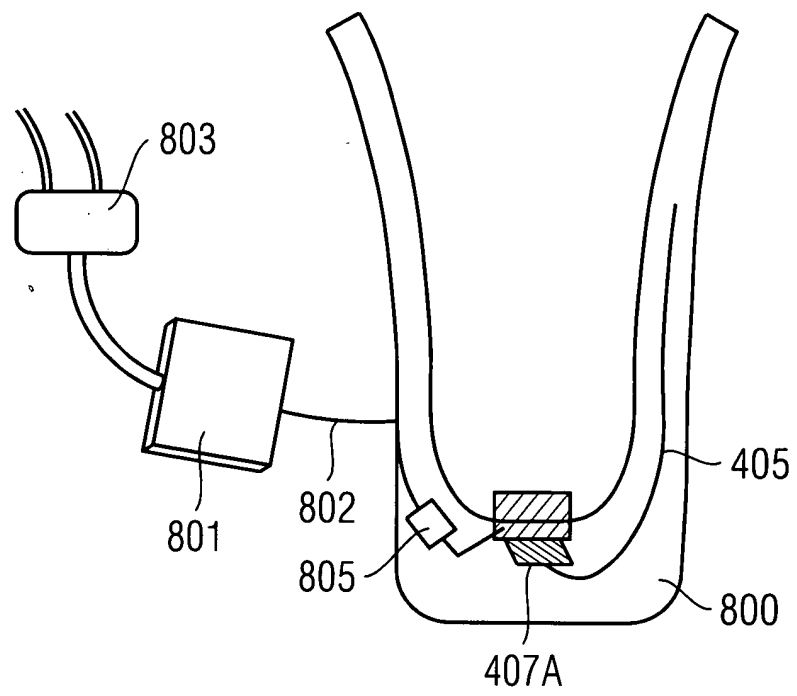


FIG 9

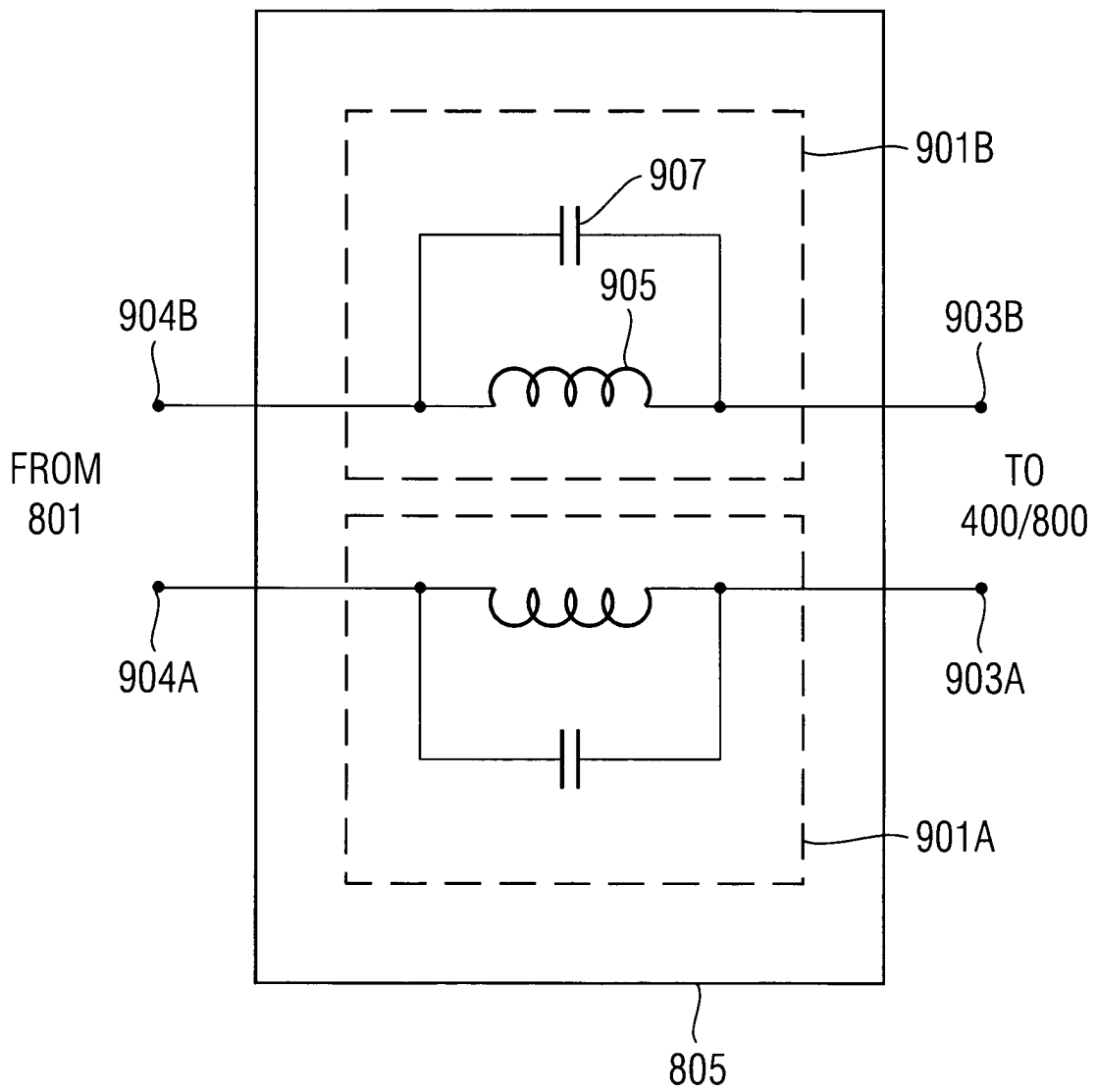


FIG 10A

Impedance of a coil at the frequencies around its first resonance.

$$Z = \frac{1+S_{11}}{1-S_{11}} \times 50$$

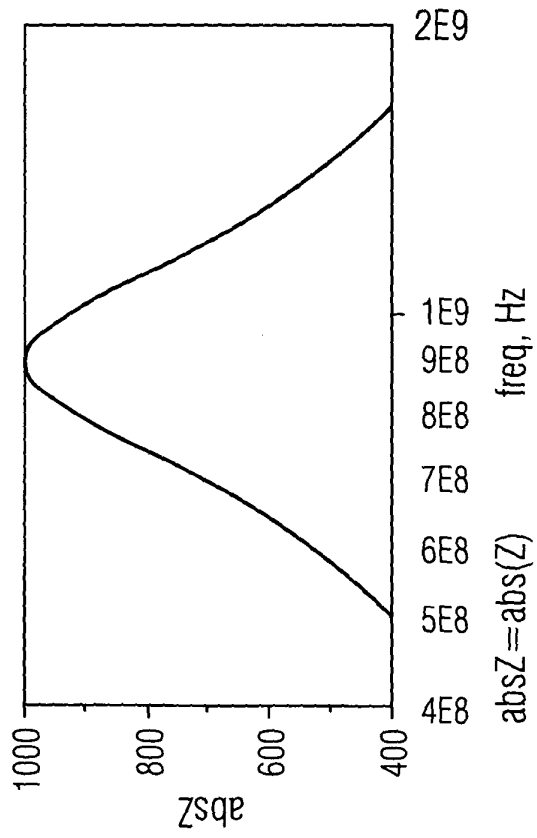
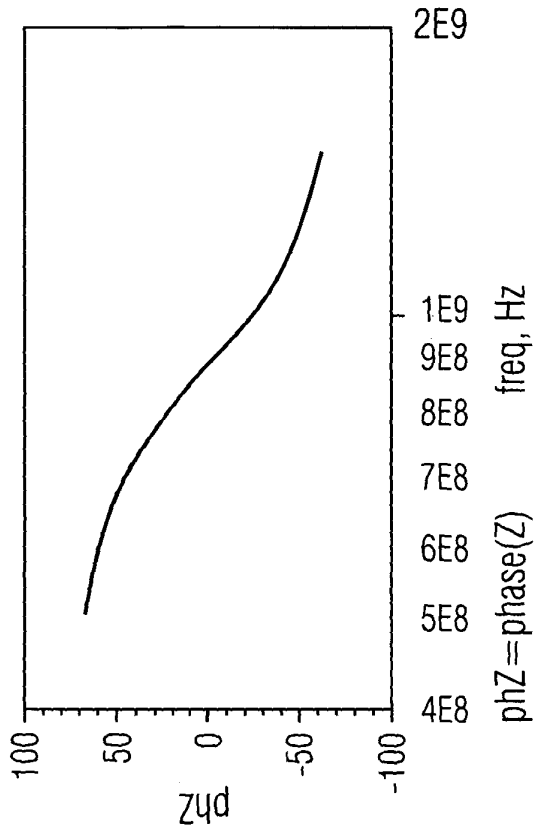


FIG 10B





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 03 00 3440

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Place of search MUNICH		Date of completion of the search 14 August 2003	Examiner Hekmat, T
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