(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 109 247 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
20.06.2001 Bulletin 2001/25

(51) Int Cl.[7]: **H01Q 1/24**, H04B 1/38

(21) Application number: **99125183.6**

(22) Date of filing: **17.12.1999**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(71) Applicant: **SIEMENS AKTIENGESELLSCHAFT**
80333 München (DE)

(72) Inventors:
- **Knudsen, Mikael B.**
  9260 Gistrup (DK)
- **Pedersen, Gert Frolund**
  9280 Storvorde (DK)

(54) **Mobile telephone and method for controlling the radiation sent into the body of a user**

(57) The invention relates to a method to control the radiation send into the body of an user of a mobile telephone and mobile telephone using different antenna elements. The antenna elements (5) have different radiation patterns in the near field. A sending signal as being applied variable to the first and second antenna elements (5).

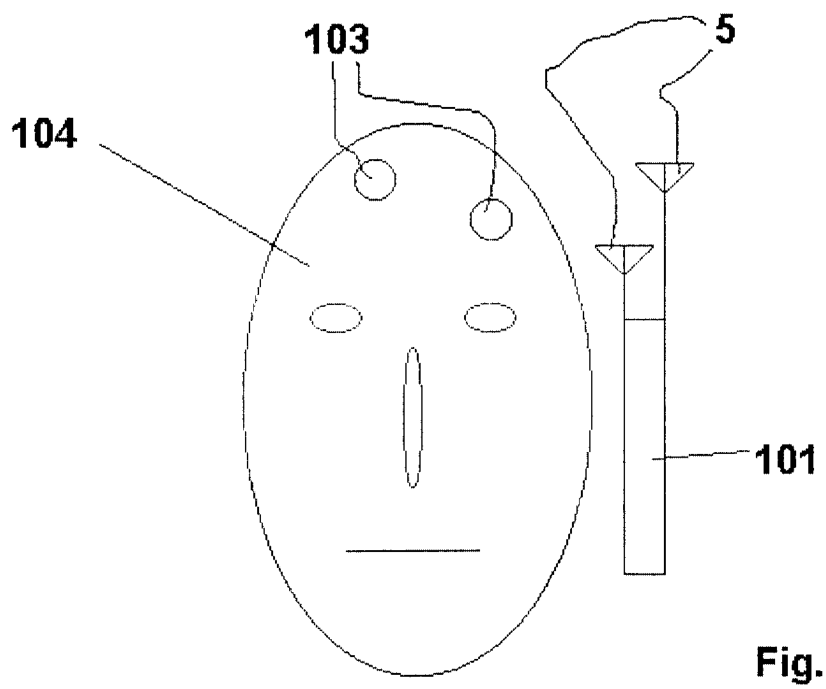

Fig. 1

EP 1 109 247 A1

Description

Prior Art

[0001] The invention relates to a method for controlling the radiation pattern sent into the body of an user of a mobile telephone and a mobile telephone using a first and second antenna element. It is already known to use antenna diversity by applying signals to different antennas.

Advantage for the invention

[0002] The method and the mobile telephone according to the invention have the advantage, that by using two antennas with a different radiation pattern in the near field, the concentration of the radiation in the body of the user of a mobile telephone is influenced. It can thereby be avoided to have single "hot spots" in the body of the user where a considerable amount of energy of the sending signal is lost. A potential health hazard of an user of the mobile telephone is therefore reduced. Further the total amount of radiation lost in the body of an user is reduced by selecting for at least for a part of the sending signal the antenna creating the minimum absolute power loss in the body of the user.

[0003] Further improvements arise from the features of dependant patent claims. The simplest way to vary the signal at the two antenna elements is by using a switch and directing the signal to either of the first or second antenna elements. Further the signal can be split by a power splitter. A very easy way for doing that is between bursts of a burst structure of the signals. By measuring the received signals over a sufficient long period it is possible to determining the influence of the user to the absolute power loss of the signals. It is then possible to detect which of the two antenna elements has the minimum loss of energy in the body of the user.

Drawings

[0004] The invention is shown in the drawings and described in greater detail in the following description. In the drawings shows figure 1 the head of the user with a mobile telephone, figure 2 to 4 different ways to vary the signal at the first and second antenna elements, figure 5 and 6 an antenna arrangement with two antenna elements and figure 7 and 8 the switching of signals for the antenna arrangement of figure 5 and 6.

Description

[0005] Figure 1 shows a head 104 of an user of a mobile telephone. The mobile telephone has the reference number 101 and is shown in a usual position when operated. Normally the telephone is held near the head of the user 104 and the mobile telephone 101 is pressed against the ear of the user. In this operating position part of the radio signal that is send from the mobile telephone 101 to a base station of the mobile telephone system is radiated into the head of the user 104. These radio signals which are send into the head of the user are suspected to have a negative effect to the health of the user. It is therefore desirable to reduce the absolute amount of radiation emitted into the body of the user. "Hot spots" should be to avoided, that means areas, in which the energy per volume is very high. This energy per volume is often called "peak SAR" (Specific Absorption Rate) that is defined as energy per unit volume. The SAR is used in various standards of different national or multinational standardisation bodies all over the world. The definition of the SAR changes with the different standards, but in general it is defined as absorbed energy per volume. Very close to antennas in the so called near field very high SAR values can occur, that are localized in very small areas. This is shown in figure 1 where the mobile telephone 101 has two antennas 5. Associated to each of these antennas 5 there is inside the head of the user 104 a hot spot 103. If the mobile telephone 101 has only one antenna 5 then there will be typically only one "hot spot" 103 that is localized always at the same region in the head 104.

[0006] Measurements of the user behaviour have shown that the position of the mobile telephone stays very much the same during a telephone call and that a specific user has the tendency to hold the mobile telephone always in the same way. When the mobile telephone 101 has only one antenna 5 it is therefore very likely that only small regions of the head of the user 104 is a subject to a larger amount of radiation every time when the telephone is operating. The biological damage is assumed to accumulate with the absolute amount of radiation send into the tissue. This concentration can significantly be reduced by using two antennas as shown in figure 1 or even more antennas (3, 4, ...). As shown in figure 1 each antenna 5 can have a seperate "hot spot" 103. The antennas 5 are made to have distinct radiation patterns in the near field, that means in the close vicinity of the antennas 5.

[0007] By using two or more antennas with a different radiation pattern in the near field (close to the antenna) the radiation pattern in the body of the user can be significantly influenced simply by using only one of two antennas 5 at the same time and switching the antennas so that they are only operated half of the time. In a TDMA system like GSM where the signals are sent in bursts, a simple way to achieve this is to operate each of the antennas 5 only every second burst. By this the radiation pattern inside the head of the user 104 can be controlled and the radiation load for a specific volume can be reduced. When having two antennas the SAR can be reduced up to 50 %, with three antennas up to 67 % etc. Multiple antennas can therefore be used to reduce the peak SAR inside the body of an user.

[0008] Further multiple antennas can be used to enhance the quality of the connection between the mobile telephone and the base station by controlling the radiation pattern sent into the body of the user. As describe earlier the behaviour of users of mobile telephones has been investigated. The results show that users tend to change their individual position of holding the mobile telephone very little. So the position of holding the telephone during a telephone communication is very stabile. Further the investigation of the user behavior showed that there are significant differences between different users, resulting in individual differences of up to 10 dB in the received or send radion signal depending on the individual user. There are users that absorb up to 10 dB more of the radio signals than others. So the link quality can vary up to 10 dB depending on which user is using the telephone and how the telephone is hold in this specific telephone call. Depending on the individual pattern how the user holds the telephone a larger or miner amount of radiation is lost in the body of the user. Further measurements showed that this loss of radiation in the body of the user is the same for sending and receiving so that users that showed very strong damping for reception also showed strong damping for the sending of radio signals. Multiple antennas can here be used to reduce the absolute amount of radiation absorbed by the body of the user. Since there is a strong correlation between the sending and receiving loss, the received signals can therefore be used to decide which of the multiple antennas shows the best reception of the signals for the specific user. This antenna is then also used for sending signals. Then the loss of radiation in the body of the user is reduced the using of this antenna also reduces the radiation load of the user. In systems where the energy of the sending signal of mobile telephone 101 can be regulated as it is the case in GSM, not only the radiation emitted into the body of the user is reduced, but also the power consumption of the mobile telephone because the mobile telephone can use a lower energy level for sending. This is also the case if not only one of the multiple antennas is selective for sending but if there is fixed pattern or sequence in which the multiple antennas are used for sending signals. Every time the antenna having the low loss characteristics is used the amount of radiation in the body of the user is reduced.

[0009] The correlation of the body loss of the user for the reception and the sending of signals was also found when the sending and receiving of the signals is separated in the frequency domain. When the users moves with the mobile telephone there are large variations of the received signal. At every point of time the received signal depends on the frequency used and the actual geometrical data of the sending channel between the base station and the mobile station. If a plurality of subsequent measurements are made it is therefore clear that there are strong variations of the measurements. The only thing that is the same over all measurements is the individual behaviour of the user or the user dependent attenuation of the received signals. Although there is a strong variation of the signal a plurality of subsequent measurements give a good idea which of the multiple antennas is, with respect to the specific user, a good antenna having the lowest body loss in the body of the user. This antenna is also the antenna that shows the minimum sending loss. This is even true for a system like GSM and nearly all other mobile systems where the sending and receiving signals have different frequency. The measurement of the received signals must be compared over a plurality of bursts, to insure that the user influences on the signal is measured and not some short time variation due to the variant geographical influences.

[0010] Figure 2 shows a first example how a first and second antenna element 5 are operated according to the invention. Reference no. 1 indicates a baseband controller that supplies the data that are to be send with the radio signal. Further the baseband controller 1 supplies control information that are used to control all elements in the mobile station. The baseband controller 1 sends and receives information from the transceiver 2. The transceiver 2 has the function to modulate the radio frequency signals with the data supplied by the baseband controller for sending this information over the radio interface. Further the transceiver has a function to receive data send over the radio interface and to transform this data into baseband data suppied to the baseband controller 1. The transceiver is therefore used for modulating or demodulating the data onto the radio frequency. The output and input of the transceiver 2 are connected to a switch 4. The switch 4 can established a connection between the transceiver 2 and one of the two antennas 5. If the antenna 4 is switched to the upper antenna 5 of figure 2 then a connection is established between this upper antenna 5 and the transceiver 2. Then the transceiver 2 can send and receive radio signals to or from the upper antenna 5 as shown in figure 2. In figure 2 this is indicated by an arrow between the switch 4 and the upper antenna 5. The switch 4 is controlled by a control logic 3. The control logic 3 is controlled by a signal from the baseband controller 1.

[0011] The switching arrangement as shown figure 2 works as following with the invention. For reducing the SAR in the user the baseband controller 1 supplies a switching signal to the control logic 3 that is operating the switch 4. In the GSM system the messages are send in bursts. Every burst the position of the switch 4 is changed, thereby sending one burst to the upper antenna 5 and the next burst to the lower antenna 5. By this switching of the bursts a reduction of the SAR is achieved, because the power concentration that is very high in the "hot spots" 103 is reduced by simply sending energy in the two "hot spots" as shown in figure 1 only every second burst.

[0012] Further the absolute absorbed power in the body of the user is reduced compared to the worse of the two antennas 5. Of cause by this method the absolute power loss in the body of the user is not so good compared to the situation where the best of the two antennas 5 is selected. A further reduction of the body loss can therefore be achieved by selecting the antenna 5 that is the best antenna for the sending of signals. As described earlier the situation changes very quickly when the mobile station is moved. What remains a constant influence is the influence of the user that is different for the different antennas 5. By using a long time measurement (long time means some seconds) the influence of the specific user of the mobile telephone can be determined and the one antenna that is less influenced by the user can be selected for the sending of radio signals. Then for the device as shown in figure 2 it is at every point of time only possible to have one of the two antennas 5 connected to the transceiver 2.

[0013] Figure 3 shows a different arrangement in which a power splitter 6 is used instead of a switch. The reference numbers 1, 2, 3 and 5 show the same elements as in figure 1. The control logic 3 supplies here a control signal that indicates a fraction of the power of the radio frequency signal to be directed to the upper antenna 5 or the lower antenna 5. This power splitter 6 is therefore a variable power splitter so that the energy of the send radio signal is divided on two antennas with variable fraction. For example it is possible to send one third of the energy in the upper antenna and two third of the energy in the lower antenna. Depending on the energy supplied to the antenna elements 5 the respective "hot spots" inside the head of the user 104 as shown in figure 1 have a respective higher or lower energy. The energy is thereby distributed over two "hot spots".

[0014] A different concept for a variable power splitter is shown in figure 4. The reference numbers 1, 2, 3 and 5 indicate the same devices as described in figure 3. In difference to figure 3 the control logic 3 supplies two signals that are used to control the amplification of amplifiers 8. These amplifiers 8, that are associated to each of the antennas 5, are thereby controlled by the control logic 3. Between the transceiver 2 and amplifiers 8 is a fixed energy splitter 7 that divides the radio signal energy in two more or less equal parts, which are then amplified by the amplifiers 8. The amplification of the amplifiers 8 is controlled by the control logic 3 so that the signals strength at each of the antennas 5 can be controlled. The fixed splitter 7 and the subsequent two amplifiers 8 are simply a different method of producing a variable power splitting of the radio signal supplied by the transceiver 2.

[0015] The following figures 5, 6, 7 and 8 show a specific antenna arrangement for the realisation of two antennas for the invention.

[0016] Figure 5 shows a perspective view of the antenna element. Figure 6 shows a view along line VI-VI of figure 5. The antenna element of figures 5 and 6 comprises a conductive plate 11 that is located above and substantially parallel to a ground plate 10. The ground plate 10 is for example the backside of a mobile telephone. Electrically connected to the conductive plate 11 is a first feed pin 14 and a second feed pin 15 and a first ground pin 12 and a second ground pin 13.

[0017] The ground plate 10 is in general the backside of a mobile telephone and is connected to a ground potential. One example for the ground plate 10 and the conductive plate 11 are, that the ground plate 10 is the backside of a metal housing of a mobile telephone and the conductive plate 11 is a metal plate. This metal plate is then held above the ground plate 10 with the help of the first and second feeding pins and the first and second ground pin. Another example for the ground plate 10 and the conductive plate 11 is the used of insulating bodies, for example plastic or ceramic materials with a metall coating.

[0018] The first and second feed pins 14, 15 and the first and second ground pins 12, 13 are made from a conductive material, in general a metal and are electrically connected to the conductive plate 11. The pins 12, 13, 14, 15 are electrically not directly connected to the ground plate 10 but are connected to switches 21, 22, that are shown in figure 7 and 8. Figure 7 and 8 show a first switch 21 that has two output connections that are connected to the first and second feeding pin 14, 15. Further the switch 21 comprises two input connection, a first input connection 23 for an antenna signal 23 and a second input connection 24 for a control signal. The antenna signal 23 is the radio signal, that has to be sent over the antenna arrangement. Depending on the control signal 24, the switch 21 either directs the antenna signal 23 to the first feed pin 14 or connects the antenna signal 23 to the second feed pin 15. The connection of the feeding pin 14 is shown in figure 7 and the connection of the feeding pin 15 is shown in figure 8. Further figures 7 and 8 show a second switch 22. The second switch 22 comprises an output connection that is connected to the first ground pin 12 and a second output connection is connected to the second ground pin 13. Further the second switch 22 comprises an input 25 that is connected to a ground potential 25, that is a same ground potential as being applied to the ground plate 10. Further the second switch 22 comprises an input for the control signal 24. Depending on the control signal the second switch 22 connects the ground potential 25 either to the first ground pin 12 or the second ground pin 13. The connection of the ground potential 25 to the first ground pin 12 is shown in figure 7. The connection of the ground potential 25 to the second ground pin 13 is shown in figure 8. By actuating the second switch 22 it is possible to selectively connect one of the first or second ground pins 12, 13 to the ground plate 10.

[0019] As shown in figure 7 and 8 the first switch 21 and the second switch 22 are operated simultaneously by the control signal. If the first feeding pin 14 is connected to the antenna signal 23 then the first ground pin 12 is connected to the ground potential 25 (figure 7). If the second feeding pin 15 is connected to the antenna signal 23 then the second ground pin 13 is connected to the ground potential 25 (figure 8).

[0020] By using this type of antenna arrangement with this type of switches it is possible to realise two different antennas having to different radiation patents in the near field by using only one conductive plate 11 and one ground plate 10. Dependent one which feed pin 14, 15 is connected to the antenna signal 23 and which ground pin 12, 13 is electrically connected to the ground plate 10 a different antenna is realised. So a mobile station comprising the type of antenna element as described in the figures 5 to 8 has two antennas with different radiation patents.

[0021] Further the concept for the embodiment of different antennas as described in the figures 5 to 8 can also be extended to 3, 4, 5 antennas by using more than two feed pins and more than two ground pins.

[0022] Although there is only one antenna arrangement, depending on how the switches are operated, there is a substantially difference in the radiation pattern emitted from the antenna arrangement. It is therefore possible to have antenna diversity with only one antenna arrangement. With antenna diversity the mobile telephone can send and receive radio signals with a different radiation pattern. The antenna arrangement of firure 5 -9 can therfor be used to reduce the SAR and the absolut power loss in the body of a user as described with respect to the figures 1 -4.

Claims

1. Method for controlling the radiation send into the body of an user (104) of a mobile telephone (101), said telephone (101) comprising at least a first and a second antenna element (5), said antenna element (5) having different radiation patterns in the near field of the antenna element (5), by variably applying a sending signal to the first and second antenna element (5).

2. Method of claim 1, characterized by, said sending signal being switched to either the first or the second antenna element (5).

3. Method according to claim 1, characterized by, said sending signal being split and supplied with a variable fraction of the sending energy to the first and second antenna element (5) at the same time.

4. Method according to any proceeding claim, characterized by, said sending signal having a burst structure and the sending signal being varied between that burst.

5. Method according to any preceding claim, characterized by, first measuring a received signal at first and second antenna elements (5) and based on said measurement determining the variation of the sending signal at the first and second antenna elements (5).

6. Method according to claims 1 to 4, characterized by, said sending signal being varied by a fixed sequence to the first and second antenna elements (5).

7. Method for controlling the radiation send into the body of an user (104) of a mobile telephone (101), by first measuring the received signals at first and second antenna elements (5) and based on said measurement determining one of the first and second antenna elements (5) for sending a signal.

8. Mobile telephone having a first and second antenna element (5) having different radiation patterns in the near field into the body of an user (104) when the telephone is operated in a normal mode, said first and second antenna elements (5) being supplied with a sending signal in a variable sequence.

9. Mobile telephone according to claim 8, characterized by a switch (4) directing the signal to either the first or the second antenna element (5).

10. Mobile telephone according to claim 8, characterized by an energy splitter directing a variable fraction of the energy of the sending signal to said first and second antenna element (5).

11. Mobile telephone according to claim 8 to 10, characterized by a receiver capable of receiving signals from that first and second antenna elements (5) and based on said received signals from said first and second antenna elements (5) determining the variation of the sending signals to the antenna elements (5).

12. Mobile telephone having a first and second antenna element (5) having different radiation patterns in the near field into the body of an user (104) when the telephone is operated in a normal mode, with a receiver capable of receiving signals from said first and second antenna elements (5) and based on said received signals from said first and second antenna elements (5) selecting one of the first and second antenna elements (5) for sending a signal.

13. Mobile telephone according to claim 8, 9, 11 and 12, characterized by, said first and second antenna elements (5) being realised by a conductive plate (11) obove a ground Plate (10), said conductive plate (11) comprising different feed pins (14, 15), and said variation being accomplished by supplying the sending signal to the different feed pins (14, 15).

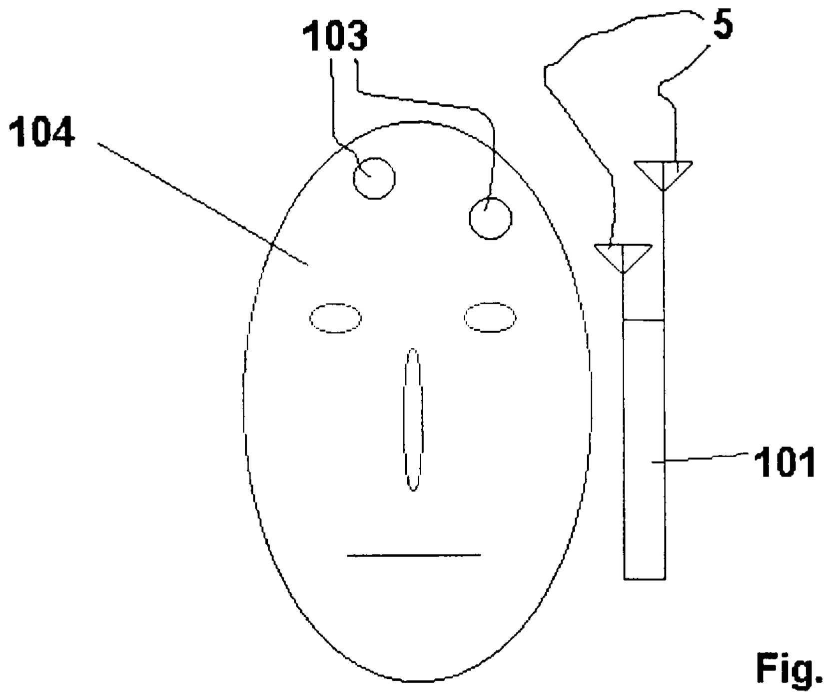

Fig. 1

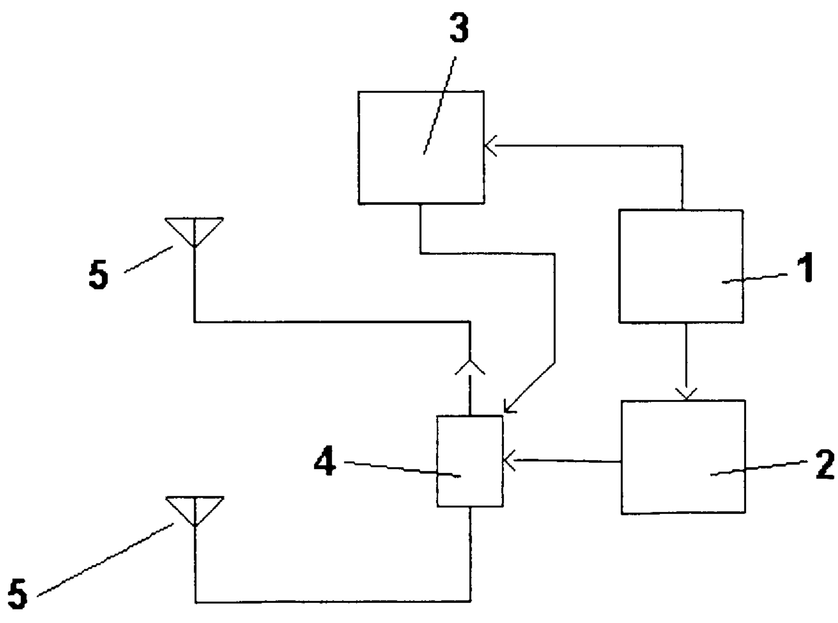

Fig. 2

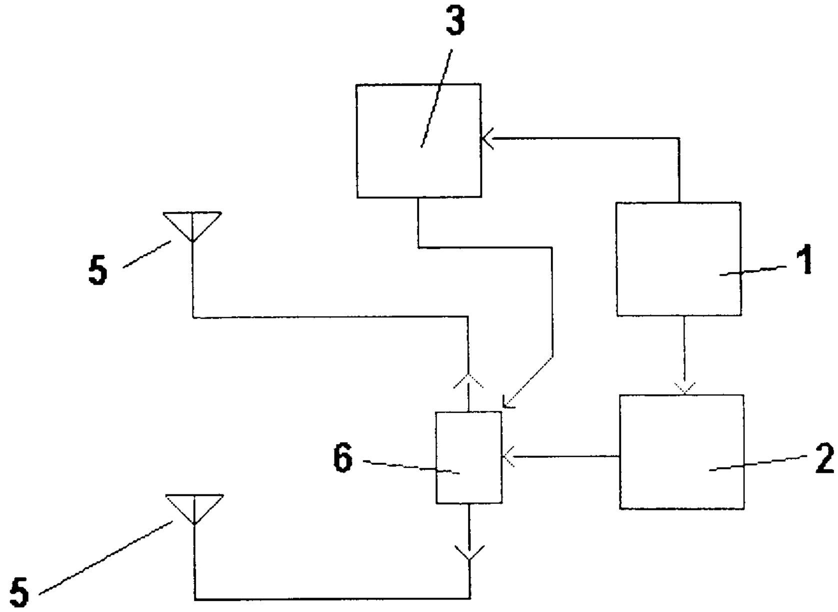

Fig. 3

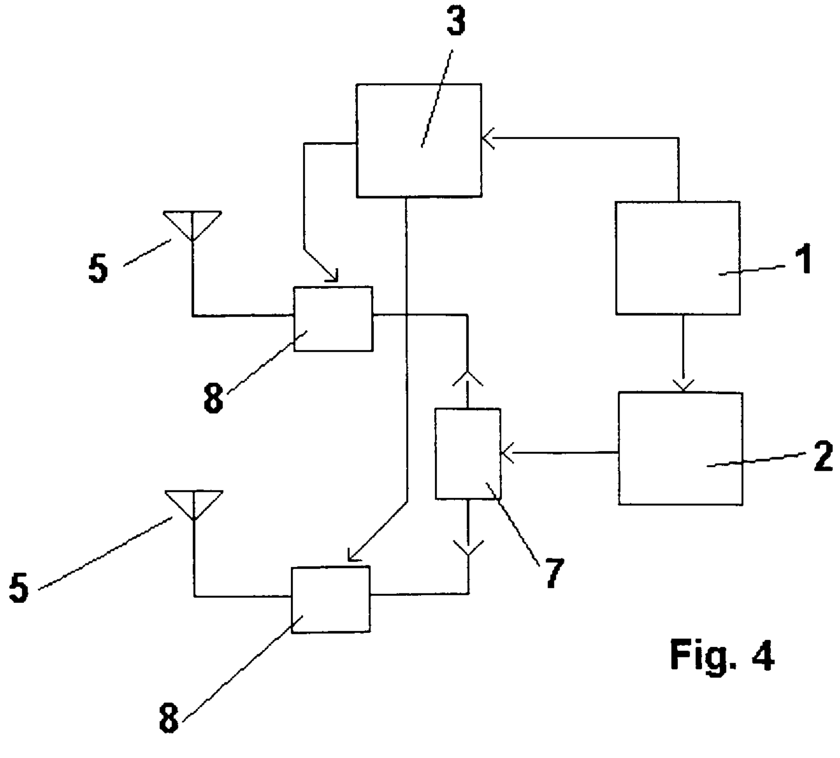

Fig. 4

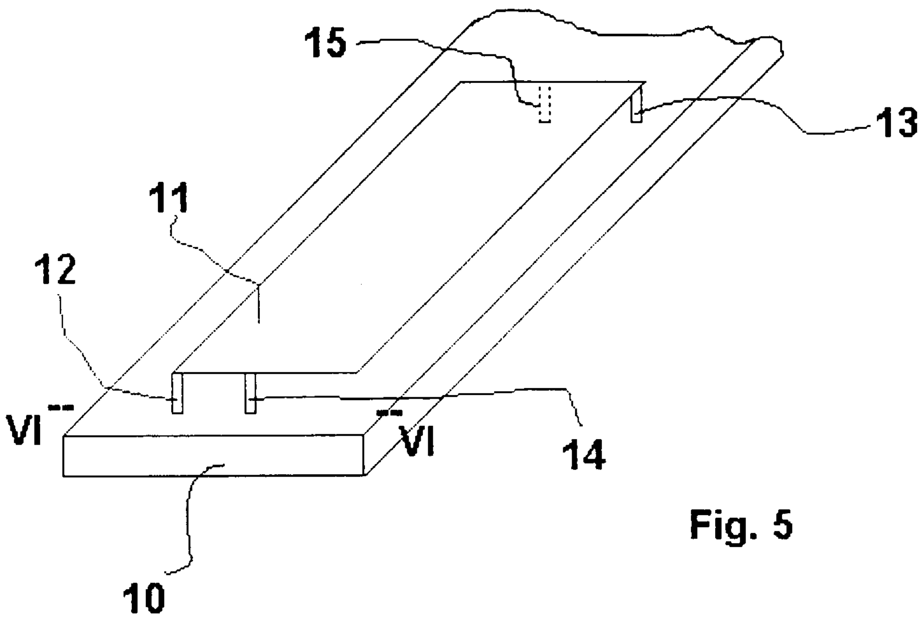

Fig. 5

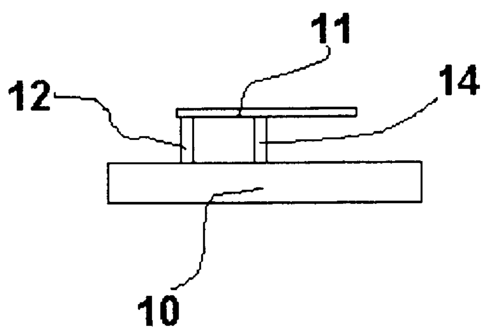

Fig. 6

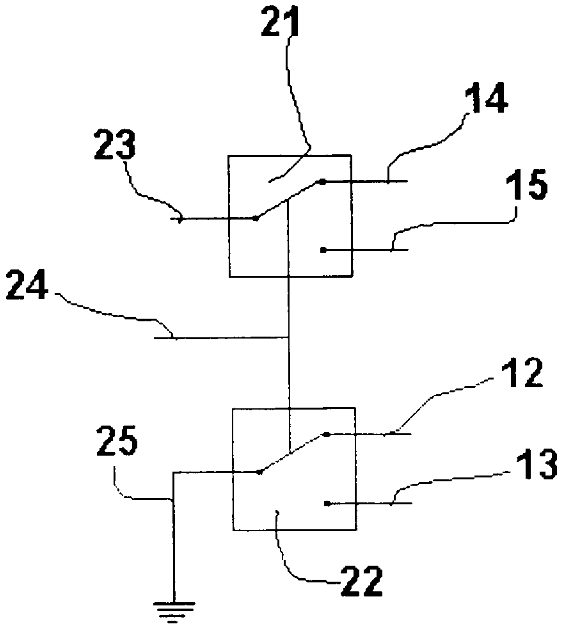

Fig. 7

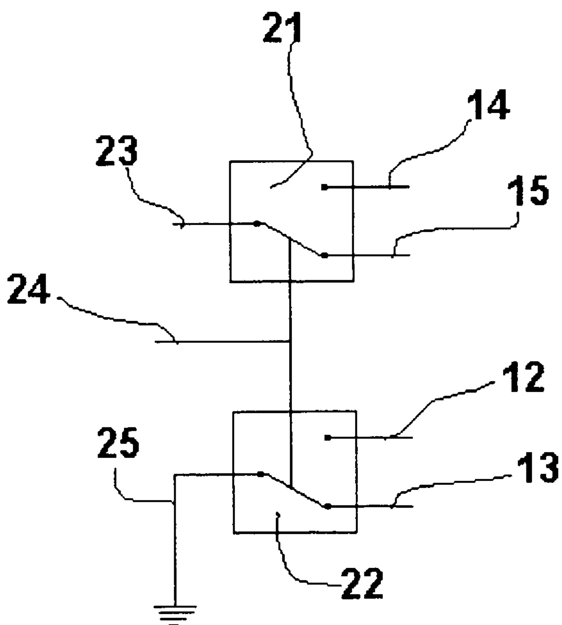

Fig. 8

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 99 12 5183

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	EP 0 959 525 A (BOSCH GMBH ROBERT) 24 November 1999 (1999-11-24) * abstract; figure 3 * * column 2, line 16 - line 50 * * column 4, line 36 - line 42 * ---	1-13	H01Q1/24 H04B1/38
X	EP 0 871 236 A (NOKIA MOBILE PHONES LTD) 14 October 1998 (1998-10-14) * abstract; figure 14 * * page 8, line 33 - line 52 * ---	1-13	
X	WO 98 01919 A (DANCALL TELECOM AS ;JENSEN NIELS JOERGEN (DK)) 15 January 1998 (1998-01-15) * abstract; figure 5 * * page 10, line 1 - line 31 * ---	1-13	
X	EP 0 752 735 A (DEUTSCHE TELEKOM MOBIL) 8 January 1997 (1997-01-08) * abstract; figures * * column 1, line 48 - column 2, line 9 * ---	1-4,6, 8-10,13	TECHNICAL FIELDS SEARCHED (Int.Cl.7)
E	EP 0 977 304 A (KONINKL PHILIPS ELECTRONICS NV) 2 February 2000 (2000-02-02) * abstract; figure 3 * ---	1-3,8-10	H01Q H04B G01R
X	WO 99 52177 A (KONINKL PHILIPS ELECTRONICS NV ;PHILIPS AB (SE)) 14 October 1999 (1999-10-14) * abstract; figures 1,4-7 * ---	1-4,6, 8-10,13	
X	EP 0 954 050 A (UNIV GRIFFITH) 3 November 1999 (1999-11-03) * abstract; figures 2,3 * -----	1-4,6, 8-10,13	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	5 June 2000	Fritz, S

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

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 99 12 5183

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

05-06-2000

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0959525 A	24-11-1999	DE 19823126 A	25-11-1999
EP 0871236 A	14-10-1998	FI 971522 A	12-10-1998
		US 6005525 A	21-12-1999
WO 9801919 A	15-01-1998	DK 74296 A	06-01-1998
		AU 3336397 A	02-02-1998
		EP 0916166 A	19-05-1999
EP 0752735 A	08-01-1997	DE 19524288 C	06-03-1997
EP 0977304 A	02-02-2000	NONE	
WO 9952177 A	14-10-1999	EP 0986837 A	22-03-2000
EP 0954050 A	03-11-1999	AU 679992 B	17-07-1997
		AU 6789194 A	20-12-1994
		WO 9428595 A	08-12-1994
		EP 0700585 A	13-03-1996
		JP 10502220 T	24-02-1998
		US 6034638 A	07-03-2000

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82