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(54) An antenna, an antenna system and a portable radio communication device comprising such an antenna system

(57) The present invention relates to an FM antenna for a portable radio communication device, wherein the FM antenna comprises a multiple turn coil radiating element (2) connected to a monopole radiating element (1).

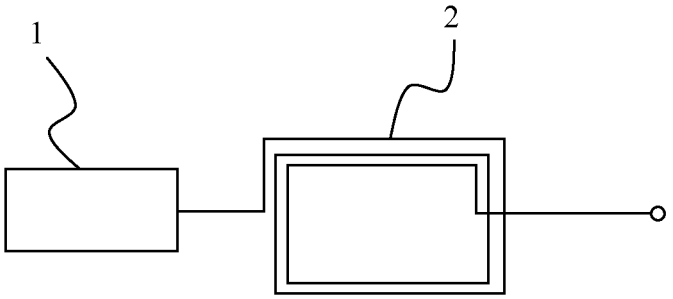

FIG. 1

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Description

FIELD OF INVENTION

[0001] The present invention relates generally to antenna device and more particularly to an antenna device for use in a portable radio communication device providing FM operation.

BACKGROUND

[0002] Internal antennas have been used for some time in portable radio communication devices. There are a number of advantages connected with using internal antennas compared to protruding antennas, of which can be mentioned that they are small and light, making them suitable for applications wherein size and weight are of importance, such as in mobile phones, PDA, portable computer or similar devices.

[0003] However, the application of internal antennas in a mobile phone puts some constraints on the configuration of the radiating element of the antenna. In particular, in a portable radio communication device the space for an internal antenna device is limited. These constraints may make it difficult to find a configuration of the antenna device that provides for desired use. This is especially true for antennas intended for use with radio signals of relatively low frequencies as the desired physical length of such antennas are large compared to antennas operating with relatively high frequencies.

[0004] One specific application operating in a relatively low frequency band is the FM radio application. The FM operating band is defined as frequencies between 88-108 MHz in most of the world and frequencies between 76-90 MHz in Japan. Prior art conventional antenna configurations, such as loop antennas or monopole antennas, fitted within the casing of a portable radio communication device will result in unsatisfactory operation in that the antenna either has too bad performance over a sufficiently wide frequency band or sufficient performance over a too narrow frequency band.

[0005] Instead, a conventional FM antenna for portable radio communication devices is usually provided in the headset wire connected to the communication device. This configuration with a relatively long wire permits an antenna length that is sufficient also for low frequency applications. However, if no external antenna is permitted this solution is obviously not feasible.

[0006] Further, a portable radio communication device is today many times provided with frequency operational coverage for other frequency bands then FM, such as GSM900, GSM1800, GPS, BT, WLAN, WCDMA and GPS. A portable radio communication device has limited space and it is thus desirable to, if possible, add multiple functionality to an antenna device.

SUMMARY OF THE INVENTION

[0007] Today, when an FM antenna is used in a mobile phone, it is realized as a wire loop, which is shortcircuited to ground and strongly inductive, which makes a match to a certain impedance value (normally 50 Ohm) difficult. From a certain length, the wire loop provides sufficient gain to meet specifications for FM operation, but in such a case the loop runs over a large part of the mobile phone and hence causes unwanted EMI radiation.

[0008] A planar multiple turn coil, typically used for a Near Field Communication (NFC) application effect less space than a single turn coil, and causes less EMI radiation, but does not provide enough gain for FM operation in a mobile phone.

[0009] An object of the present invention is to provide an FM antenna for a portable radio communication device, occupies limited space of the portable radio communication device.

[0010] This object, among others, is according to the present invention attained by an FM antenna, an antenna system and a portable radio communication device, respectively, as defined by the appended claims.

[0011] By providing an FM antenna for a portable radio communication device, wherein the FM antenna comprises a multiple turn coil radiating element connected to a monopole radiating element an effective FM antenna is achieved, which occupies limited space, causes reduced EMI radiation, and exhibits improved gain compared to a single loop FM antenna.

[0012] Advantageously, the monopole radiating element is connected to an outer end of the multiple turn coil radiating element and an inner end of the multiple turn coil radiating element is connectable to an FM receiver, whereby wiring is minimized.

[0013] Preferably, the multiple turn coil radiating element is configured for near field communication operation, whereby both FM and NFC applications can be provided by the same antenna device.

[0014] The monopole radiating element is preferably configured to have a capacitance corresponding to the inductance of the multiple turn coil radiating element, whereby the antenna performance is improved.

[0015] By preferably providing the FM antenna with a high input impedance amplifier connected to the inner end, and optionally a varactor connected between the inner end and ground, an active antenna device can be achieved.

[0016] By preferably providing the FM antenna with a standard (50 Ohm) amplifier connected to the inner end a passive antenna device can be achieved.

[0017] The FM antenna is advantageously provided with first switching means configured to connect the multiple turn coil radiating element to ground or to the monopole radiating element, and second switching means configured to connect the multiple turn coil radiating element to an FM receiver or to an NFC transceiver, in order to provide an antenna device having FM Rx and

NFC functions. By preferably configuring the second switching means to connect the multiple turn coil radiating element to an FM receiver, to an FM transmitter or to an NFC transceiver, also FM Tx is provided.

[0018] An antenna system for a portable radio communication device, as well as a portable radio communication device, are provided.

[0019] Further preferred embodiments are defined in the dependent claims.

BRIEF DESCRIPTION OF DRAWINGS

[0020] 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 is a schematic diagram showing an FM antenna according to a first embodiment of the present invention.

Fig. 2 is a schematic diagram showing an FM antenna according to second embodiment of the present invention.

Fig. 3 is a schematic diagram showing an FM antenna according to third embodiment of the present invention.

Fig. 4 is a schematic diagram showing an antenna system according to a fourth embodiment of the present invention.

Fig. 5 is a schematic diagram showing an antenna system according to a fifth embodiment of the present invention.

Fig. 6 is a schematic diagram showing an antenna system according to a sixth embodiment of the present invention.

Fig. 7 is a schematic diagram showing an antenna system wherein the embodiments showed in Figs. 4 and 5 are combined.

DETAILED DESCRIPTION OF THE INVENTION

[0021] 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.

[0022] In the following description and claims, the term radiating element is used. It is to be understood that this term is intended to cover electrically conductive elements arranged for receiving and/or transmitting radio signals.

[0023] An FM antenna for a portable radio communication device according to a first embodiment of the present invention will now be described with reference to Fig. 1.

[0024] The FM antenna comprises a multiple turn coil radiating element 2 and a monopole radiating element

1. The monopole radiating element 1 is connected to an outer end of the multiple turn coil radiating element
2. An inner end of the multiple turn coil radiating element 2 is configured to be connected to an FM receiver or FM transceiver.

[0025] An alternative configuration is achieved if the monopole radiating element 1 is connected to an inner end of the multiple turn coil radiating element 2, and an outer end of the multiple turn coil radiating element 2 is configured to be connected to an FM receiver or FM transceiver. However, the alternative configuration usually entails longer connection wiring, which in that regard is a less attractive solution.

[0026] The monopole radiating element 1 is preferably arranged close to an edge/corner of a printed wiring board (PWB) of the portable radio communication device in which it is mounted in, in order to improve the gain of the FM antenna. The gain is further improved by having the monopole radiating element 1 arranged partly or completely outside metalized parts of the PWB. If the monopole radiating element 1 is arranged over or partly over metalized part of the PWB the higher above thereof the better.

[0027] The monopole radiating element 1 is preferably arranged close to the multiple turn coil radiating element 2, in order to minimize wiring.

[0028] The size of the monopole radiating element 1 is preferably tuned to 93 MHz, which is approximately the middle of the FM band. A typical size for the monopole radiating element 1 is 6x6 mm.

[0029] The multiple turn coil radiating element 2 preferably comprises as many turns as possible in an outer periphery thereof, to provide as large empty area therein as possible enclosed by the multiple turns. By having the inner coil area as large as possible the magnetic field created by multiple turn coil radiating element 2 is maximized.

[0030] The multiple turn coil radiating element 2 is preferably an NFC radiating element per se, i.e. configured for an NFC application, typically having an inductance value of 0.3-4 μH. The NFC operation frequency is 13.56 MHz, and a first example configuration of the multiple turn coil radiating elements 2 has a size of 25x10 mm, with 13 turns and an inductance of about 3.5 μH. A sec-

ond example configuration of the multiple turn coil radiating elements 2 has a size of 16x16 mm, with 11 turns and an inductance of about 3.5 μH.

[0031] The monopole radiating element 1 is configured to have a capacitance value approximately corresponding to the inductance of the multiple turn coil radiating element 2. In this case the FM antenna, i.e. the monopole radiating element 1 and the multiple turn coil radiating element 2 together, resonate and radiate at the FM band with a centre frequency of about 92 MHz.

[0032] By having an FM antenna provided by the combination of a multiple turn coil radiating element 2 and a monopole radiating element 1, wherein their respective capacitance and inductance values balance each other, an FM antenna occupying limited space and providing a high gain is achieved. The use of the multiple turn coil radiating element 2 in the FM antenna further gives the possibility to utilize it for an NFC application in the portable radio communication device.

[0033] The multiple turn coil radiating element is preferably a planar element. However, it can also be utilized folded over e.g. the edge of the PWB. Further, the multiple turn coil radiating element can be positioned perpendicular to the PWB, in front of the PWB edge. By being folded the NFC function is improved by reduced directive sensitivity, at the same time not decreasing the FM function. For best FM performance both the multiple turn coil radiating element and the monopole radiating element should be oriented in the same plan and in folded the same way.

[0034] A second embodiment of an FM antenna for a portable radio communication device according to the present invention is illustrated in Fig. 2. This second embodiment of the present invention is identical to the first embodiment described above, apart from the following.

[0035] The monopole radiating element 1 is connected to an inner end of the multiple turn coil radiating element 2, which inner end of the multiple turn coil radiating element 2 is also configured to be connected to an FM receiver or FM transceiver. An outer end of the multiple turn coil radiating element 2 is grounded.

[0036] A third embodiment of an FM antenna for a portable radio communication device according to the present invention is illustrated in Fig. 3. This third embodiment of the present invention is based on an FM antenna according to the first embodiment described above.

[0037] The FM antenna comprises a monopole radiating element 1 connected to an outer end of a multiple turn coil radiating element 2. An inner end of the multiple turn coil radiating element 2 is connected to an amplifier 3 configured to be connected to an FM receiver or FM transceiver.

[0038] A varactor 4 is preferably connected between ground and the inner end of the multiple turn coil radiating element 2 for tuning of the FM antenna. When an active FM antenna is utilized a high input impedance amplifier 3 is used. When a passive FM antenna is utilized a typically 50 Ohm input impedance amplifier 3 is used.

[0039] A fourth embodiment of an FM antenna for a portable radio communication device according to the present invention is illustrated in Fig. 4. This fourth embodiment of the present invention is based on an FM antenna according to the first embodiment described above.

[0040] The FM antenna comprises switching means 5 connecting an outer end of a multiple turn coil radiating element 2 to ground or to a monopole radiating element 1. An inner end of the multiple turn coil radiating element 2 is connected to a matching network 16.

[0041] When the NFC transceiver 8 is operating the switching means 5 is connected to ground, and the FM antenna can be utilized for NFC applications. When the NFC transceiver 8 is not operating the switching means 5 is connected to the monopole radiating element 1 and the FM antenna can be utilized for FM operation as described below.

[0042] A fifth embodiment of an antenna system for a portable radio communication device according to the present invention is illustrated in Fig. 5. This fifth embodiment of the present invention is based on an FM antenna according to the third embodiment described above.

[0043] The antenna system comprises a monopole radiating element 1 connected to an outer end of a multiple turn coil radiating element 2. An amplifier 3, connected to an FM receiver 12, and an FM transmitter 13 are connected to an inner end of the multiple turn coil radiating element 2.

[0044] Alternatively, as illustrated in dotted lines, the amplifier 3 and the FM transmitter 13 are one at a time connected to the inner end of the multiple turn coil radiating element 2 through switching means 11. The connection between the switching means 11 and the FM transmitter 13 is preferably grounded through a varactor 4, in order to tune the FM antenna for FM Tx. A varactor can also be used to tune the antenna for FM Rx, arranged before the amplifier like in Fig. 3.

[0045] A sixth embodiment of an antenna system for a portable radio communication device according to the present invention is illustrated in Fig. 6. This sixth embodiment of the present invention is based on a combination of an FM antenna according to the third embodiment and the fourth embodiment, respectively, as described above.

[0046] The antenna system comprises first switching means 5 configured to connect an outer end of a multiple turn coil radiating element 2 to ground or to a monopole radiating element 1. The antenna system further comprises second switching means 14 configured to connect an inner end of the multiple turn coil radiating element 2 to an amplifier 3, connected to an FM receiver 12, or to a matching network 16 connected to an NFC transceiver 8.

[0047] During NFC operation the first switching means 5 is connected to ground and the second switching means 14 is connected to the matching network 16. For

FM Rx the first switching means 5 is connected to the monopole radiating element 1 and the second switching means 14 is connected to the amplifier 3. Optionally, a varactor can be used to tune the FM antenna, like in Fig. 3. For this application the switching means 5 and 14 can be exchanged with passive filters.

[0048] A seventh embodiment of an antenna system for a portable radio communication device according to the present invention is illustrated in Fig. 7. This seventh embodiment of the present invention is based on a combination of an FM antenna according to the third, fourth and the fifth embodiments, respectively, as described above.

[0049] The antenna system comprises first switching means 5 configured to connect an outer end of a multiple turn coil radiating element 2 to ground or to a monopole radiating element 1. The antenna system further comprises second switching means 17 configured to connect an inner end of the multiple turn coil radiating element 2 to an FM receiver 12, to a FM transmitter 13, or to a matching network connected to an NFC transceiver 8.

[0050] During NFC operation the first switching means 5 is connected to ground and the second switching means 17 is connected to the matching network. During FM transmission the first switching means 5 is connected to the monopole radiating element 1. During FM reception the second switching means 17 is connected to the FM receiver 12, and for FM Tx the second switching means 17 is connected to the FM transmitter 13. For this application the first switching means 5 can be exchanged with a passive filter.

[0051] Like in previous embodiments a varactor can be used to tune the FM antenna to FM RX or FM Tx, respectively.

[0052] 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. An FM antenna for a portable radio communication device, **characterized in that**
said FM antenna comprises a multiple turn coil radiating element (2) connected to a monopole radiating element (1).

2. The FM antenna according to claim 1, wherein said monopole radiating element (1) is connected to an outer end of said multiple turn coil radiating element (2) and an inner end of said multiple turn coil radiating element (2) is connectable to an FM receiver.

3. The FM antenna according to claim 1, wherein said monopole radiating element (1) is connected to an inner end of said multiple turn coil radiating element (2), an outer end of said multiple turn coil radiating element (2) is grounded, and said inner end of said multiple turn coil radiating element is connectable to an FM receiver.

4. The FM antenna according to any of claims 1-3, wherein said multiple turn coil radiating element (2) is configured for near field communication operation.

5. The FM antenna according to any of claims 1-4, wherein said monopole radiating element (1) is configured to have a capacitance corresponding to the inductance of said multiple turn coil radiating element (2).

6. The FM antenna according to any of claims 1-5, comprising a high input impedance amplifier (3) connected to said inner end, and a varactor (4) connected between said inner end and ground.

7. The FM antenna according to any of claims 1-5, comprising an amplifier (3) connected to said inner end, and said monopole radiating element (1) and said multiple turn coil radiating element (2) are matched to said amplifier (3).

8. The FM antenna according to any of claims 1-7, comprising first switching means (5) configured to connect said multiple turn coil radiating element (2) to ground or to said monopole radiating element (1), and second switching means (14; 17) configured to connect said multiple turn coil radiating element (2) to an FM receiver (12) or to an NFC transceiver (8).

9. The FM antenna according to claim 8, wherein said second switching means (14; 17) is configured to connect said multiple turn coil radiating element (2) to an FM receiver (12), to an FM transmitter (13) or to an NFC transceiver (8).

10. An antenna system for a portable radio communication device **characterized in that** it comprises an FM antenna according to any of previous claims and an FM receiver connected thereto.

11. An antenna system according to claim 10, comprising an NFC transceiver connected thereto.

12. An antenna system according to claim 10 or 11, comprising an FM transmitter connected thereto.

13. A portable radio communication device, **characterized in that** it comprises an antenna system according to any of claims 10-12.

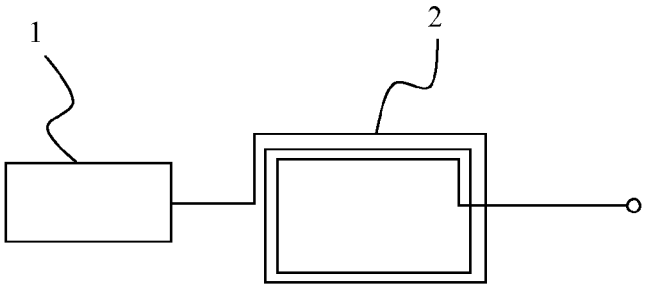

FIG. 1

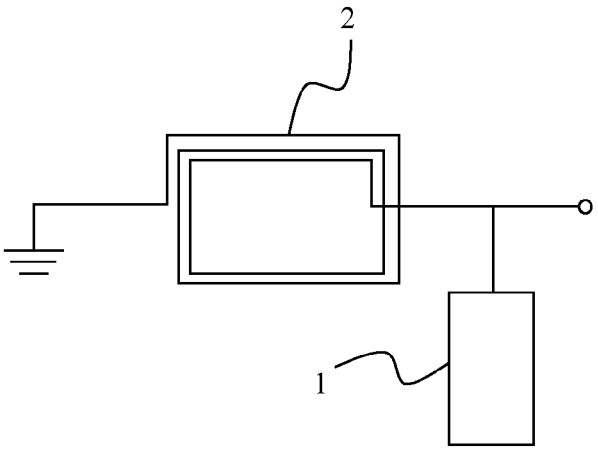

FIG. 2

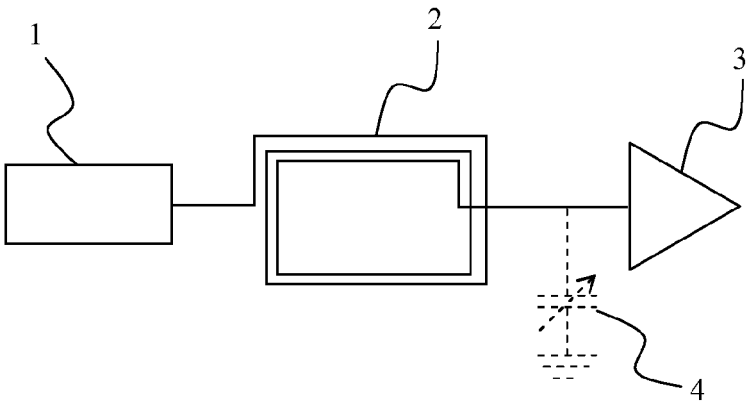

FIG. 3

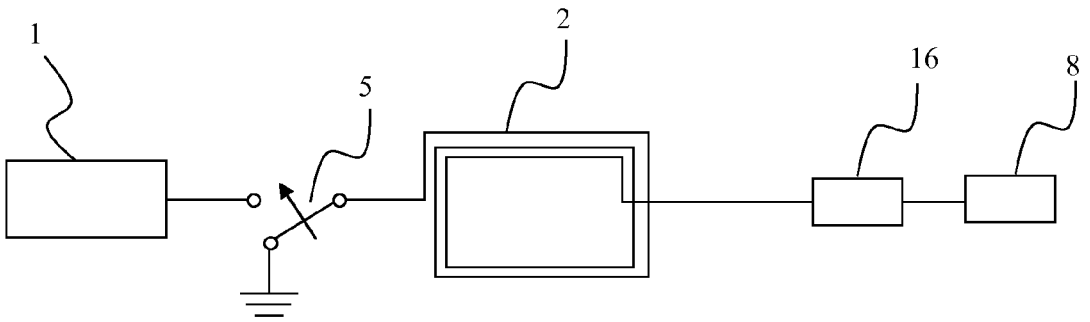

FIG. 4

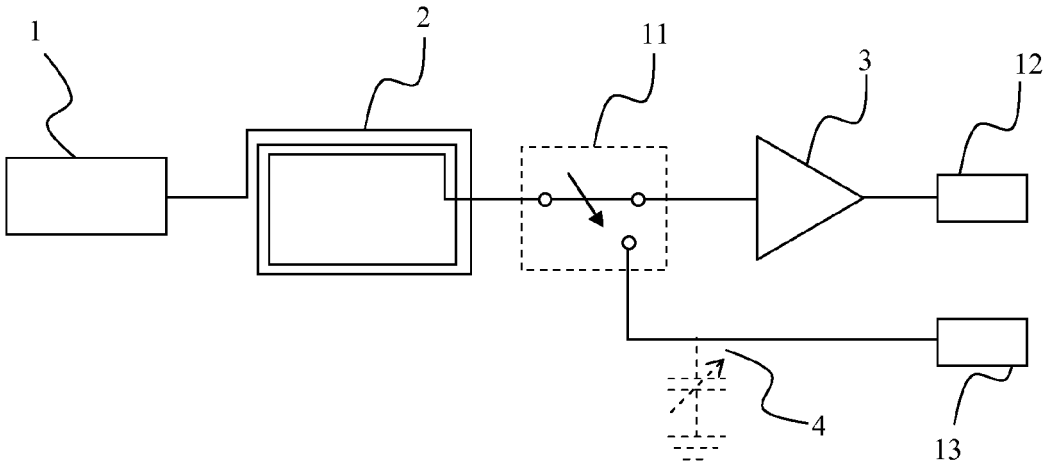

FIG. 5

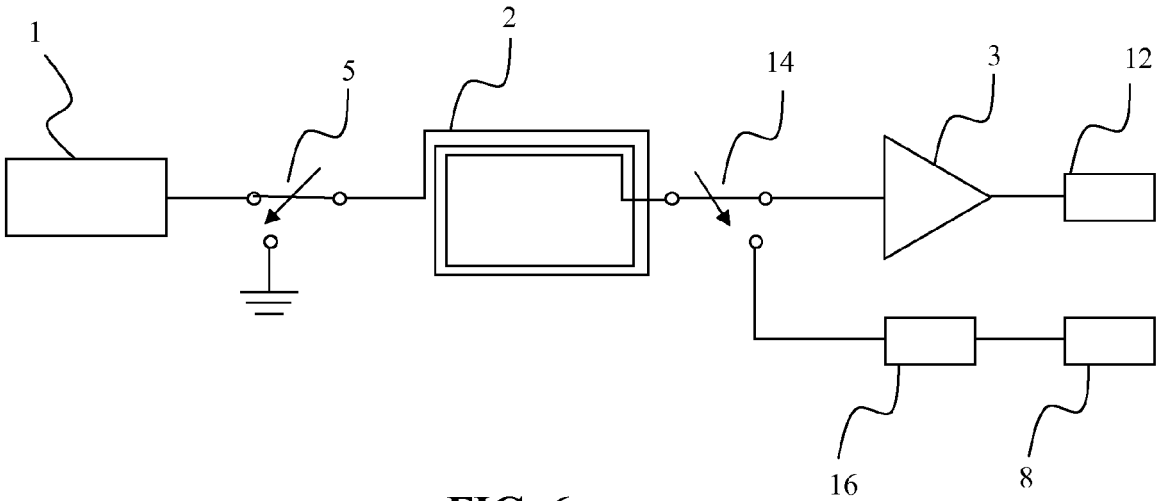

FIG. 6

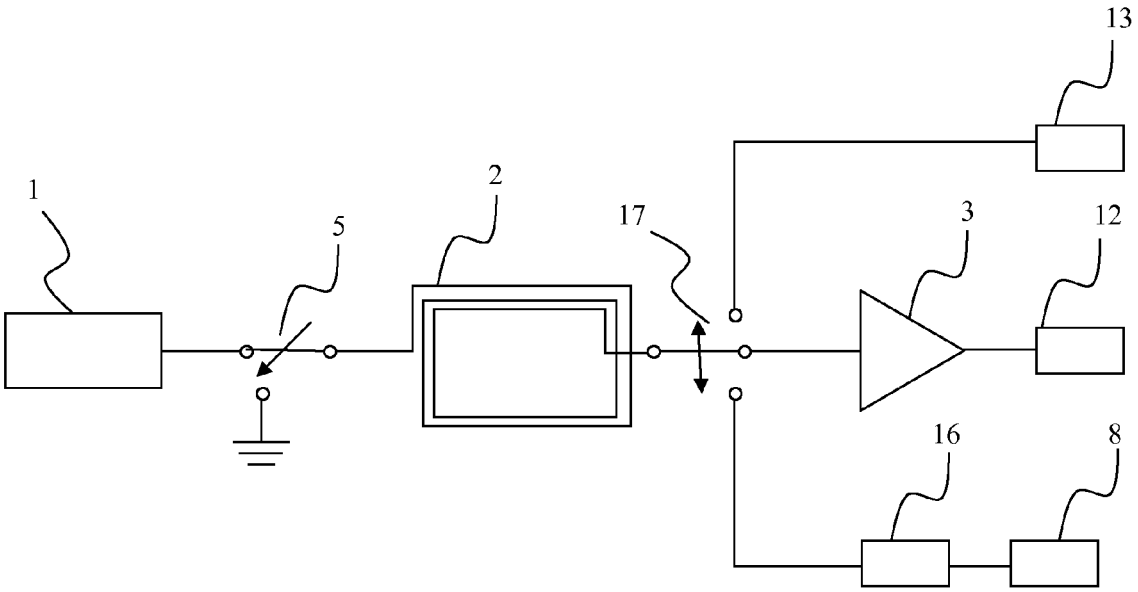

FIG. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 09 15 2428

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)
H01Q

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	7 July 2009	Wattiaux, Véronique

CATEGORY OF CITED DOCUMENTS

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