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(71) Applicant: **NOKIA MOBILE PHONES LTD.**
P.O. Box 86
SF-24260 Salo(FI)

(72) Inventor: **Saarnimo, Timo**
Patäjätie 3 F
SF-24260(FI)

(74) Representative: **Eder, Ephry**
E. EDER & CO. 39 Cranbrook Road
Ilford Essex IG1 4NH(GB)

(54) Antenna for radio telephone.

(57) The present invention concerns a small-size antenna for radio telephone. The antenna comprises two parallel, mutually spaced plates (21,22), the first plate (21) being electrically conducive and the second plate (22) being e.g. a glass fibre circuit board of which one surface is metal-coated and on the other surface, facing the first plate (21), are disposed second or higher-order matching circuits (S) implemented with separate components.

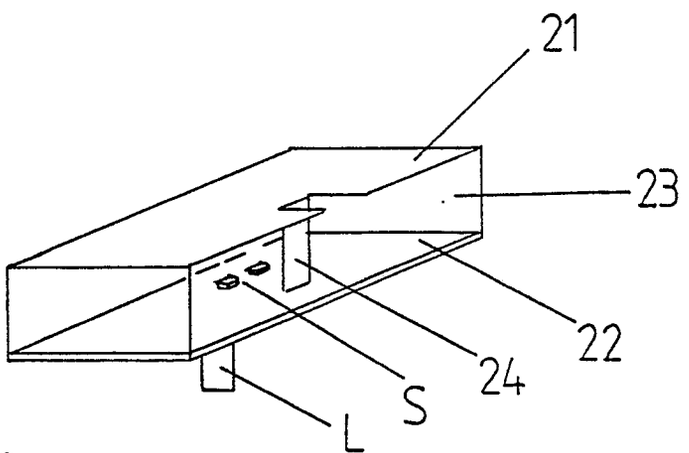

Fig. 2

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Antenna for radio telephone

The present invention concerns a small-size antenna for radio telephone, comprising two parallel plates disposed at a space from one another, provided with an insulator therebetween.

The object of the invention is to provide a small-size antenna for a radio telephone, the matching of which with the antenna input lead is of higher order and wide-band, and said matching being maximally compact.

In conjunction with radio telephones is known in prior art the so-called PIFA antenna (Planar Inverted F-Antenna), also referred to as resonator antenna. The PIFA antenna is composed of two parallel conducive plates interconnected by a conductor of appropriate width so that the capacitance between the plates is in resonance with the inductance of this conductor. The antenna input lead is carried at an appropriate distance from said conductor through one of the plates to the opposite plate. The antenna is matched to the input lead by selecting an appropriate spacing between the input lead and the conductor connecting the plates. The input impedance is determined by said spacing. The difficulty in implementing the above described PIFA antenna of prior art accordingly is that the antenna element has to be brought at the desired frequency into internal resonance which is thus determined by the capacitance of the plates and the inductance of the conductor connecting them. In case the size of the antenna element is restricted, as owing to the other dimensions of the radio telephone, the endeavour to achieve resonance at a given frequency implies that the length or width of the conductor connecting the plates may become impractical.

Another drawback of the PIFA antenna is that the resonant circuit constituted by the plates and the conductor connecting them is of the first order, and it therefore has narrow band character.

The object of the present invention is to provide an antenna which eliminates the drawbacks encountered in conjunction with the PIFA antenna and at the same time, maintains the small antenna size. This object is mainly achieved in that the first plate is an electrically conducive plate and the second plate is an insulator plate, on one surface of which, that which is opposite with reference to the first plate, is provided a substantially coherent metallic layer acting as ground level, and on the other surface facing the first plate is disposed a matching circuit in such manner that it matches the antenna impedance to the impedance of the antenna input lead of the radio telephone.

It is thus understood that, according to the invention, the conductor connecting the plates of the PIFA antenna is eliminated, whereby the antenna element need not be in resonance and one of the antenna plates is replaced by a circuit board on which a higher-order, and therefore wideband, matching circuit can be placed.

The invention is more closely described referring to the figures attached in which

Fig. 1 presents the design drawing of the PIFA antenna of prior art,

Fig. 2 presents the design drawing of the antenna of the invention,

Fig. 3 presents a schematic design of the matching circuit.

In Fig. 1 is presented the construction of the PIFA antenna embodying the state of art. The antenna comprises two conducive plates 1 and 2, wherebetween is placed an insulating layer 3. The thickness of the insulating layer is l_e. The conducing plates 1 and 2 are interconnected with a conductor 4, its width being l_j. To the antenna is supplied a signal by the coaxial cable 5 serving as the feeder lead, passing through the second plate 2 and the insulating layer 3 being connected to the conducive plate 1. The space between the feeder lead 5 and the lead connecting the plates is l. The desired feed impedance can be selected by varying said distance.

In the antenna of the invention, the conductor 4 connecting the plates in the antenna design of Fig. 1 has been eliminated. One of the conducive antenna plates has been replaced with a thin glass fiber circuit board 22, of which the surface lying farther away from the insulator between the plates 21 and 22 has been coated with metal. Said surface, which is pointing downwards in Fig. 2, acts as a ground level. On that surface of the plate 22 which faces the insulator 23 between the plates 21 and 22, i.e. the electrically conducive plate 21, has been dispcsed a matching circuit S including chips and its microconductor strips. The matching circuit S is advantageously of one of the second order but the higher-order matching circuits may equally be used. From the matching circuit S the signal is carried to the antenna plate 21 through a flat-lead 24. The purpose of the insulation 23 between the antenna plates is to brace the plates 21 and 22 and to keep them appropriately spaced. For insulation material, so-called honeycomb paper has been used, which is aramide fibre paper saturated with phenolic resin and embossed in honeycomb configuration. Other appropriate insulations may equally be used. The circuit board 22 is also provided with a connector L by which the antenna is connected to the radio components of the radio telephone.

The matching circuit on the plate 22 may be implemented e.g. as shown in Fig. 3. Here, the antenna feed impedance has been matched to 50 ohms with the second-order matching circuit of bandpass type, composed of two capacitances C1 and C2 and reactances w_1L1,w_2L2. The electrical equivalent connection of the antenna plate comprises a resistance R and a capacitance C connected in parallel and inductance L in series therewith. In a free space, the bandwidth of a test specimen constructed, when connected to the telephone chassis, was measured and found to be 860-990 MHz with the standing wave ratio SWR < 2.

The distance of the antenna from the conducive chassis of the radio telephone affects the matching of the antenna, whereby when the chassis is essentially altered, the matching circuit has also to be redesigned. The matching circuit of Fig. 3 is primarily exemplary. The matching circuit and the plastic housing of the antenna, as well as the plastic materials of the radio telephone housing cause some signal attenuation.

With the antenna matching of the invention, a higher-order, and therefore a greater, bandwidth matching is obtained than with the PIFA antenna, the external dimensions of the antenna being unchanged. In addition, the matching is compact because the matching circuit is accomodated within the antenna. For instance, it may be mentioned that as regards bandwidth, the antenna is at the same time usable in the 900 MHz NMT network and in the E-TACS-network with 52 x 30 x 7.5 mm antenna size.

The antenna of the invention has also the additional advantage that when the telephone is held in hand the matching improves and the useful frequency range increases implying that the antenna is not greatly sensitive to environmental effect.

The antenna constituting the object of the invention may also be so implemented that the antenna is integrated within the housing of the radio telephone in conjunction with the radio components so that no separate antenna connector is needed. The matching circuit may then be disposed on the circuit board containing the radio components. Such integration is advantageous because it is simple and there is no plastic material causing losses between the antenna element and the chassis of the radio telephone. The shape designing of the radio telephone is moreover easier as there are less external components.

Claims

1. An antenna for a radio telephone, comprising opposing, parallel plates (21,22) disposed at a distance from one another, wherebetween is advantageously placed an insulating material layer (23), **characterized** in that the first layer (21) is an electrically conducive plate and the second plate (22) is an insulator plate, on one surface of the latter, opposite to the first plate (21), is disposed a substantially uniform metal layer which acts as ground plane, and on the other surface, facing the first plate (21), is disposed a matching circuit (S) so as to match the antenna impedance with the impedance of the antenna input lead of the radio telephone.

2. Antenna for radio telephone according to claim 1, **characterized** in that the matching circuit (S) is coupled with the first, electrically conducive plate (21) by a flat lead (24).

3. Antenna for radio telephone according to claim 1, **characterized** in that the matching circuit (S) has been implemented with discrete components.

4. Antenna for radio telephone according to claim 1, **characterized** in that the matching circuit (S) is of the second or higher order.

5. Antenna for radio telephone according to claim 1, **characterized** in that the second plate (22) is provided with a connector for connecting the antenna to the antenna input lead.

6. Antenna for radio telephone according to claim 1, **characterized** in that the second plate (22) is a glass fibre circuit board.

7. Antenna for radio telephone according to claim 1, **characterized** in that the antenna has been integrated inside the housing of the radio telephone.

8. Antenna for radio telephone according to claim 7, **characterized** in that the matching circuit (S) is located on the circuit board of the radio unit of the radio telephone.

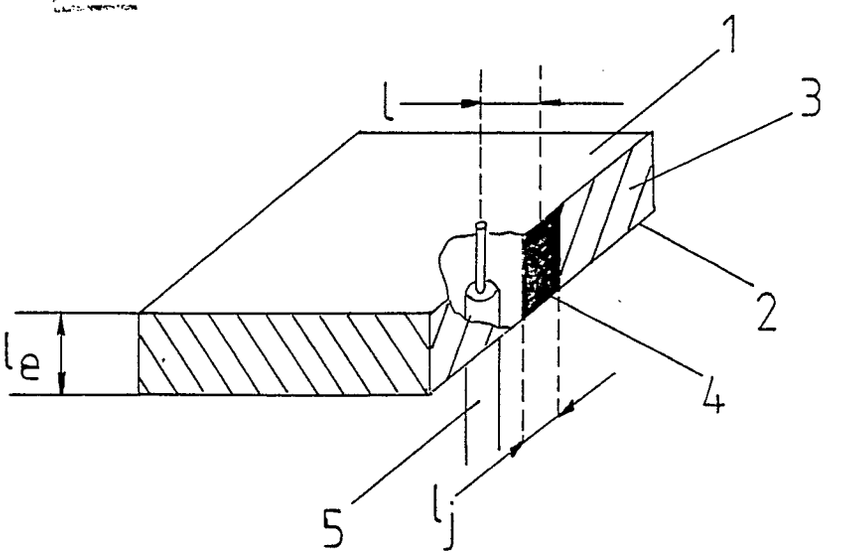

Fig. 1

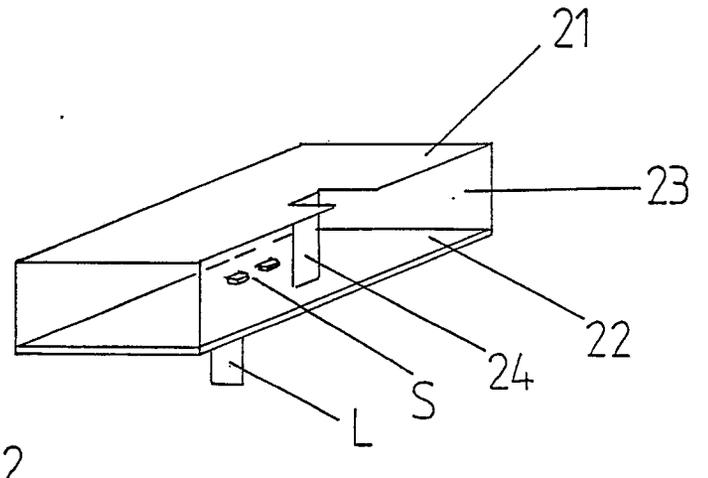

Fig. 2

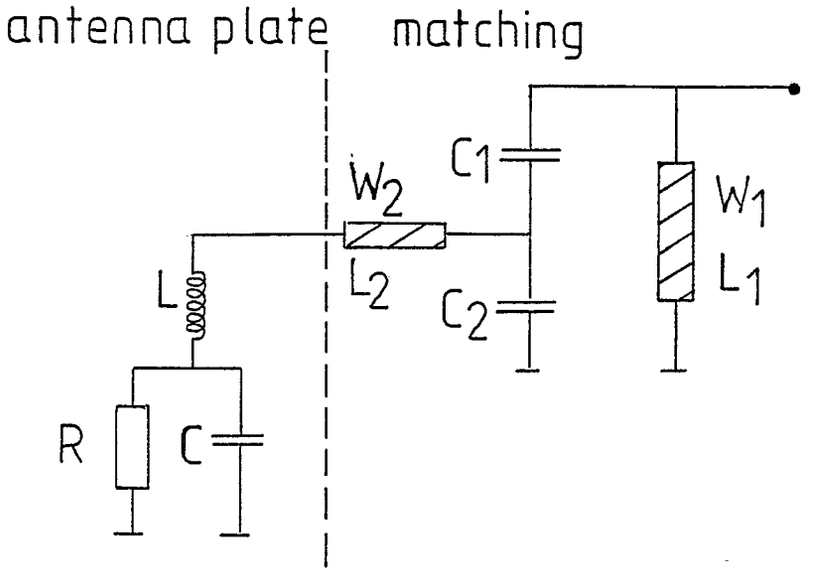

Fig. 3