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(54) **ANTENNA DEVICE**

ANTENNENVORRICHTUNG

SYSTEME D'ANTENNE

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(73) Proprietor: **Perlos AB**
223 70 Lund (SE)

(72) Inventor: **BLOM, Carl, Gustaf**
S-453 33 Lysekil (SE)

(74) Representative: **Wallengren, Yngvar**
Patentbyran Y Wallengren AB
Box 116
331 21 Värnamo (SE)

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Description

TECHNICAL FIELD

[0001] The present invention relates to an antenna device for a radio communications apparatus operating in the frequency range of 800-3000 MHz and including a radiator, a dielectric resonator that is galvanically connected to a feed line of the antenna and that is operative to feed it.

BACKGROUND ART

[0002] On small portable radio communications apparatus, so-called mobile telephones, use has previously been made of a plurality of different antenna types, including rod antennae of the quarter wave or half wave type, helix antennae, etc. One common denominator for all of these prior art designs and constructions is that attempts have been made to keep the physical dimensions of the antenna as small as possible, the degree of efficiency as high as possible and the band width as large as possible. Certain antenna types have proved to be successful in one or two of these respects, but no truly optimum design and construction has yet been developed.

[0003] In particular in such situations where transmission and reception take place at great distances in terms of frequency, it is important that the antenna is of the wide band type.

[0004] WO-A-9509454 discloses an antenna device designed for transmitting RF energy through a dielectric barrier, such as a window.

[0005] This antenna device has on the "indoor" side of the window a dielectric resonator galvanically connected to a feed line via an exciter strip. On the "outdoor" side of the window there is a second dielectric resonator coupled to the first resonator by a resonance mode coupling. The second resonator is galvanically connected to a radiator via an exciter strip.

[0006] Due to its physical size this antenna device could not be used in the same technical field as this invention i.e. as an antenna in a mobile phone.

PROBLEM STRUCTURE

[0007] The present invention has for its object to realise an antenna of the type disclosed by way of introduction which obviates the drawbacks inherent in prior art models. In particular, the present invention has for its object to realise an antenna device which has a good band width, which has small physical dimensions and which is insensitive to changes in the earth plane. Furthermore, the present invention has for its object to realise an antenna device which is simple and economical in manufacture and which displays a high level of mechanical strength.

SOLUTION

[0008] The objects forming the basis of the present invention will be attained if the antenna disclosed by way of introduction is characterized in that the radiator is galvanically discrete from the resonator, that it is connected to earth and that it is disposed to be fed by the resonator capacitively and/or inductively.

[0009] Further advantages will be attained if the antenna device is moreover characterized in that the radiator is a rod radiator which is connected in its one end to a coil, that the coil surrounds at least a part of the dielectric resonator and that the end of the coil facing away from the rod radiator is connected to earth.

[0010] These characterising features will realise an antenna which satisfies the objects established in the present invention.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWING

[0011] The present invention will now be described in greater detail hereinbelow, with particular reference to the accompanying Drawing which shows a vertical part cross section through an antenna device designed according to the invention.

DESCRIPTION OF PREFERRED EMBODIMENT

[0012] There is a proliferation on the market of different so-called dielectric resonators which, for instance, are employed as active elements in wide band filters. One supplier of such resonators is the Japanese company Murata.

[0013] In principle, such a dielectric resonator is constructed as a hollow body which may possibly be cylindrical and which has a through channel provided with a thin metal layer extending out on one end surface of the resonator in order also to extend to the circumferential surface of the resonator. Otherwise, the material in the resonator is a ceramic substance with high dielectricity constant, of the order of magnitude of between 40 and 200, but preferably between 80 and 100.

[0014] The dielectric resonator which is employed in the device according to the present invention has been given reference numeral 5 in its entirety and encompasses a cylindrical body of insulating, preferably ceramic material of high dielectricity constant, preferably of the order of magnitude of between 80 and 100. The higher the dielectricity constant, the smaller will be the physical dimensions of the resonator at the same resonance frequency, while a high dielectricity constant entails a slightly poorer degree of efficiency and possibly also a slightly reduced band width. Values as high as 200 may possibly be employed.

[0015] The antenna device has a connection terminal 1 with a metallic centre conductor 2, a metallic outer sleeve 3 and an insulation 4 in between. The centre con-

ductor 2 is galvanically connected to the resonator 5.

[0016] The resonator 5 has a central channel 7 which is coated with a thin metal layer, a metalisation 8. The metal layer 8 of the channel extends up on the upper end surface of the resonator in the Drawing figure and, thereby, one end metal layer 9 covers the entire end surface. Further, the resonator also has a metal layer 10 on its outer surface or circumferential surface. The metal layers 8, 9 and 10 are galvanically interconnected.

[0017] The upper end of the centre conductor 2 of the connection terminal 1 is, as was intimated above, galvanically connected to the metal layer 8 of the channel 7 via a contact device 11, for example in the form of a sock soldered in the metal layer 8 and the conductor 2.

[0018] The outer sleeve 3 of the connection terminal 1 is, via a short connection lead 12, in galvanic communication with a coil 13 which, in its upper end, merges in a radiator in the form of a rod 14. The connection lead 12, the coil 13 and the radiator 14 may be made of an enamelled copper wire or an insulated metal wire of other, preferably durable metal alloy. Between the inner surface of the coil 13 and the outside of the outer metal layer 10 of the resonator 5, there is a small gap 15. There is thus disposed between the inside of the coil and the outside of the resonator a non-conductive dielectric which may consist of air, but which may also consist of an insulating layer of plastic or rubber-like type.

[0019] It is entirely possible to realise a dielectric resonator for approx. 1 GHz in the form of a cylinder of a length of 9 mm and a diameter of 3.5 mm. In a prototype antenna, use has been made of 0.88 mm wire diameter in both the coil 13 and the radiator 14, in which event the coil had approx. 3 turns and the rod length was approx. 45 mm. The antenna is set to a central frequency of 900 MHz and operates as a quarter wave radiator.

[0020] The dielectric resonator has a well-defined natural resonance frequency which manifests itself as a very narrow and high "peak" in scan transmission measurement. The resonance frequency is selected to be at a level just above the desired upper operating frequency for the antenna. The inductive portion of the antenna, i. e. the coil 13, is dc-earthed, which will have as a consequence that the resonator is gradually coupled over to the coil, either capacitatively or inductively, but preferably both. By optimisation of the number of turns and/or pitch in the coil, as well as the distance between the coil and the resonator, the transfer between the resonator and the coil may be made adequate. At the same time as the transfer is optimised, an increase in the band width is also ensured. A band width of as much as 15 percent of the central frequency of the antenna device is possible.

[0021] An antenna of this type is also less sensitive to variations in the earth substrate, whereby such chassis currents as may be induced in a resonant chassis can be reduced. This property may further be improved if the end of the coil 13 facing away from the radiator 14 is provided with a body 16, possible a hollow cylinder, of absorbent ferrite.

[0022] In the foregoing, the antenna has been described as a rod radiator of quarter wave length. However, the present invention may also be applied to other types of radiators, of both the quarter wave and half wave type. For example, helix antennae may be selected.

Claims

1. An antenna device for a radio communications apparatus operating in the frequency range of 800-3000 MHz including a radiator (14), a dielectric resonator (5) that is galvanically connected to a feed line (2) of the antenna and that is operative to feed it, **characterized in that** the radiator (14) is galvanically discrete from the resonator (5), **that it** is connected to earth (3) and that it is disposed to be fed by the resonator (5) capacitively and/or inductively.

2. The antenna device as claimed in Claim 1, **characterized in that** the radiator (14) is a rod which, in its one end, is connected to a coil (13); that the coil surrounds at least a part of the dielectric resonator (5); an that the end of the coil facing away from the rod radiator is connected to earth (3).

3. The antenna device as claimed in Claim 2, **characterized in that** there is disposed, about the end portion of the coil (13) connected to earth or its connection line to earth (12), an annual body (16) of ferrite.

4. The antenna device as claimed in Claim 2 or 5, **characterized in that** the dielectric resonator (5) is in the form of a dielectric body (6) with a through channel (7), the defining surface of the cannel, the one end of the body and its outer surface having a metal layer (8, 9, 10; **and that** the supply line (2) is galvanically connected to the metal layer (8) of the channel while the metal layer (10) of the outer surface is located a slight distance from adjacent surfaces of the coil (13).

5. The antenna device as claimed in any of Claims 1 to 4, **characterized in that** the resonance frequency of the dielectric resonator (5) is selected to be at a value immediately above the desired upper operating frequency of the antenna device.

Patentansprüche

1. Eine Antennenvorrichtung für ein Funkkommunikationsgerät, das in einem Frequenzbereich von 800 bis 3.000 MHz arbeitet, mit einem Strahler (14), ei-

nem dielektrischen Resonator (5), der galvanisch mit einer Zufuhrleitung (2) der Antenne verbunden ist und der für deren Versorgung betrieben wird, **dadurch gekennzeichnet, dass** der Strahler (14) vom Resonator (5) galvanisch getrennt ist, dass er mit Erde (3) verbunden ist und dass er derart angeordnet ist, dass er durch den Resonator (5) kapazitiv und/oder induktiv versorgt wird.

2. Die Antennenvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** der Strahler (14) ein Stab ist, der an seinem einen Ende mit einer Wendel (13) verbunden ist; dass die Wendel zumindest einen Teil des dielektrischen Resonators (5) umgibt; und dass das vom stabförmigen Radiator abgewandte Ende der Wendel mit Erde (3) verbunden ist.

3. Die Antennenvorrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** ein ringförmiger Körper (16) aus Ferrit etwa im Endbereich der Wendel (13) angeordnet ist, der mit Erde verbunden ist oder dessen Verbindungsleitung mit Erde (3) verbunden ist.

4. Die Antennenvorrichtung nach einem der Ansprüche 2 oder 3, **dadurch gekennzeichnet, dass** der dielektrische Resonator (5) die Form eines dielektrischen Körpers (6) mit einem Durchgangskanal (7) hat, wobei die definierende Oberfläche des Kanals, das eine Ende des Körpers und seine äußere Oberfläche eine Metallschicht (8, 9, 10) aufweisen; und dass die Zufuhrleitung (2) galvanisch mit der Metallschicht (8) des Kanals verbunden ist, während die Metallschicht (10) der äußeren Oberfläche mit einem geringen Abstand zu benachbarten Oberflächen der Wendel (13) angeordnet ist.

5. Die Antennenvorrichtung nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** die Resonanzfrequenz des dielektrischen Resonators (5) derart ausgewählt wird, dass deren Wert unmittelbar über der gewünschten oberen Betriebsfrequenz der Antennenvorrichtung liegt.

Revendications

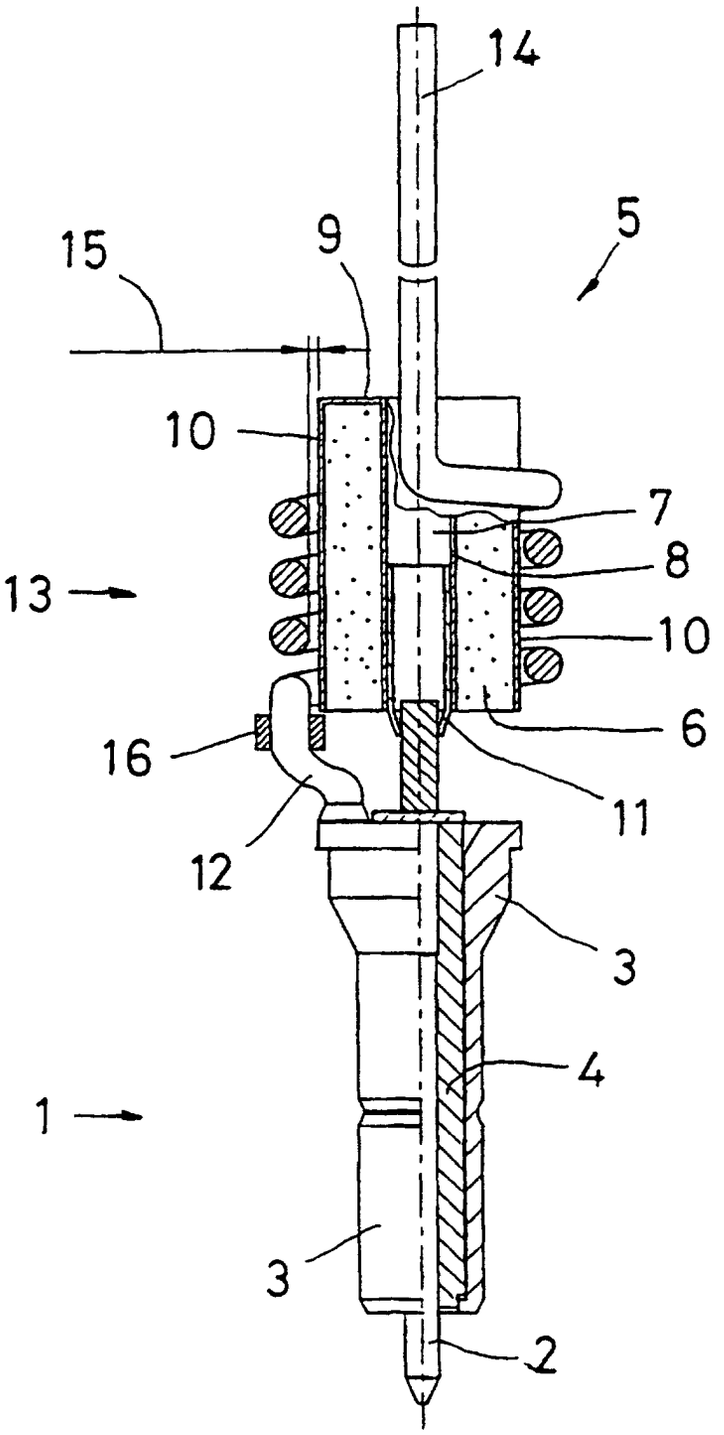
1. Système d'antenne pour un appareil de radiocommunication fonctionnant dans la plage de fréquence de 800 à 3000 MHz, comprenant un élément rayonnant (14), un résonateur diélectrique (5) qui est galvaniquement connecté à une ligne d'alimentation (2) de l'antenne et qui sert à alimenter l'élément rayonnant, **caractérisé en ce que** l'élément rayonnant (14) est galvaniquement distinct du résonateur (5), **en ce qu'**il est connecté à la terre (3) et **en ce qu'**il est disposé pour être alimenté par le résonateur (5) de façon capacitive et/ou inductive.

2. Système d'antenne selon la revendication 1, **caractérisé en ce que** l'élément rayonnant (14) est une tige qui est connectée, à sa première extrémité, à un enroulement (13) ; **en ce que** l'enroulement entoure au moins une partie du résonateur diélectrique (5) ; et **en ce que** l'extrémité de l'enroulement tournée à l'opposé de l'élément rayonnant à tige est connectée à la terre (3).

3. Système d'antenne selon la revendication 2, **caractérisé en ce qu'**un corps annulaire (16) de ferrite est disposé autour de la partie d'extrémité de l'enroulement (13) connectée à la terre, ou autour de sa ligne de connexion à la terre (12).

4. Système d'antenne selon la revendication 2 ou 5, **caractérisé en ce que** le résonateur diélectrique (5) est sous la forme d'un corps diélectrique (6) à canal traversant (7), la surface de définition du canal, la première extrémité du corps et sa surface extérieure comportant une couche de métal (8, 9, 10) ; et **en ce que** la ligne d'alimentation (2) est galvaniquement connectée à la couche de métal (8) du canal tandis que la couche de métal (10) de la surface extérieure est placée à une légère distance des surfaces adjacentes de l'enroulement (13).

5. Système d'antenne selon une quelconque des revendications 1 à 4, **caractérisé en ce que** la fréquence de résonance du résonateur diélectrique (5) est choisie de manière à avoir une valeur immédiatement supérieure à la fréquence de fonctionnement supérieure désirée du système d'antenne.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