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(54) **Compact antenna for vehicles**

(57) Compact antenna for vehicles, which comprises a resonant element (2) extending in a projecting manner from the vehicle for transmitting signals to a transceiver apparatus (4). According to the invention, the resonant element (2) is essentially composed of a shaped element (3) made of metallic material and connected, in a circuit arrangement, to the transceiver apparatus (4) and a metallic conductor (5) which is helically wound and electrically connected to the shaped element (3). The antenna in question is advantageously designed for resonance operation in the bands of 900 MHz to 1800 MHz used by mobile phones commercially available nowadays, without the need for the introduction of active circuit components. The height (H) of the resonance element (2) is of substantial importance for determining operation of the antenna (1) in the higher band (1800 MHz), while its form is decisive for operation of the antenna (1) in the lower band (900 MHz).

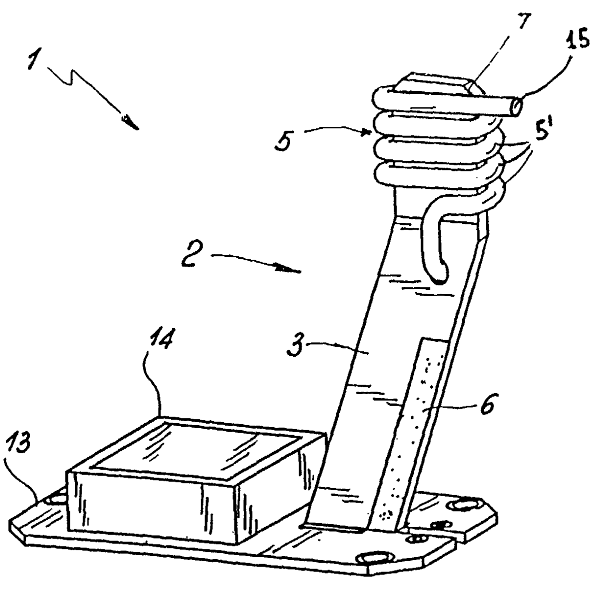

Fig. 1

EP 1 329 986 A1

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Description

Field of the invention

[0001] The present invention relates to a compact antenna for vehicles such as motor cars, lorries or the like, in particular for the use of transceiver equipment.

Background art

[0002] At present, as is known, the antennae used in the sector of vehicles for road travel are generally composed of a fixed part and a movable part which forms the rod of the antenna. The fixed part is mounted projecting on the vehicle bodywork at a maximum height which is normally subject to restrictions defined in compliance with precise safety regulations for vehicles.

[0003] In greater detail, these regulations may impose tighter restrictions for antennae designed for passive operation than for antennae associated with active components.

[0004] As is known, moreover, irrespective of the restrictions imposed by regulations, in the motor-vehicle sector, for aesthetic reasons there is an increasing need to provide antennae with particularly small dimensions.

[0005] This has resulted in the production of rodless antennae composed solely of the fixed part. Obviously, in the case of antenna designs which do not envisage the presence of the removable rod part, the restrictions on the fixed part consist in limitations on the overall height of the antenna.

[0006] With particular reference to a passive antenna, i.e. an antenna without a transistor or amplification components, it is known that the transmission of the signal between the antenna and a transceiver apparatus is optimum in the case of antenna lengths able to produce a resonant circuit, i.e. typically equal to $\lambda/4$, $5/8\lambda$ and $1/2\lambda$ (where λ = wavelength of the transmitted signal) and in the case of antenna impedance values substantially equal to the impedance of the transceiver apparatus (and therefore typically $\cong 50\ \Omega$).

[0007] In greater detail, in the case of antenna lengths equal to $\lambda/2$, the correct transmission of the signal may require the insertion of a match circuit consisting, for example, of a substantially loss-free LC circuit.

[0008] At present, as is known, the transmission of telephone signals may be performed by means of transceiver equipment able to communicate in one or more frequency bands. In particular, cellular phones able to operate at the frequencies of 900 MHz or 1800 MHz or selectively at both the abovementioned frequencies are known. These frequencies correspond, for resonance at $\lambda/4$, to antennae with a length of about 8 and 4 cm, respectively.

[0009] Rodless antennae which, for reasons of constructional simplicity and low production costs, do not envisage the use of active components for signal amplification must necessarily operate by means of resonance for optimisation of transmission. This means that the form, and in particular the height, of these antennae are greatly dependent upon the restrictions imposed by the wavelengths of the transmission frequencies.

[0010] Therefore, in particular in order to permit operation, at all the transmission frequencies, of the transceiver equipment commercially available today, in keeping with the dimensional constraints imposed by safety regulations or production requirements or also simple industrial design requirements, suitable configurations of antennae have been developed, although, as is known, these hitherto have been unable to provide performance characteristics which are entirely satisfactory.

[0011] In greater detail, the circumstances described above have in particular meant that, in order to reduce the height of antennae, in particular for the operation of telephone equipment in the lowest frequency bands, suitable forms of antennae have been developed in order to achieve resonance with heights less than those of $\lambda/4$, $5/8\lambda$ and $1/2\lambda$.

[0012] For this purpose, antennae have been made, for example with a reduced height, obtained by means of conductor elements which are helically wound in the manner of springs, but nevertheless have a resonance behaviour which is same as corresponding conductor elements with heights of $\lambda/4$, $5/8\lambda$ and $1/2\lambda$.

[0013] Alternatively, antennae obtained by means of thin metallised filaments formed on large printed-circuit areas also able to transmit by means of the principle of resonance, but with a reduced height, have also been developed.

[0014] All these antennae of the known type, although being able to achieve resonance within the bands used by telephone equipment, in practice, however, have the drawback that they possess a passband which is too narrow or a horizontal dimension which is too large for the production or simple industrial design requirements. In other words, they allow efficient transmission of the signal only within a limited frequency range. In fact, the ends of the passbands are affected by signal reflection phenomena due to the variation in impedance and basically a partial loss of resonance. More technically speaking, it has been ascertained that these known constructional forms of antenna have a high mismatch at the ends with return losses and therefore SWR characteristics which are not optimum.

[0015] In greater detail, in the case of antennae composed of elements with a helical form, the small thickness of the conductor element limits in practice the band widening effect due to the area described by the spirals (which allows better reception in a wider frequency range).

[0016] Similarly, the filaments formed in printed circuits, although achieving resonance with low heights, result in an undesirable limitation of the passband due to the limited thickness of the filaments and the limited volumetric space present between the said filaments. This fact therefore offsets the positive effect of widening of the resonance range due to the form of the spirals designed on the printed circuit.

[0017] At the moment, therefore, it has not been possible to solve entirely the problem of transmitting, via rodless antennae of the passive type, telephone signals for transceiver equipment at the lowest frequencies (900 MHz) and at several transmission frequencies (900 MHz and 1800 MHz) using electromagnetic structures with a substantially horizontal radiation pattern.

[0018] A further drawback which has not yet been entirely solved consists in the difficulty of providing an antenna which allows optimum operation both at the frequency of 900 MHz and at the frequency of 1800 MHz and which at the same time has a reduced height.

Disclosure of the invention

[0019] The essential object of the present invention is therefore that of eliminating the drawbacks of the art as described above, by providing a compact antenna for vehicles which projects from the vehicle over a limited height and allows at the same time resonance operation for the transmission of telephone signals in all the frequency bands used by transceiver equipment.

[0020] Another object of the present invention is in particular that of providing an antenna, in particular devoid of active components, which allows the transmission of telephone signals both in the frequency band of 900 MHz and in the frequency band of 1800 MHz.

[0021] Another object of the present invention is that of providing an antenna which has extremely low production costs and a low loss factor.

[0022] A further object of the present invention is that of providing an antenna which is constructionally simple and operationally entirely reliable.

These objects, together with others, are all achieved by the compact antenna for vehicles in question, which comprises at least one resonant element projecting from a vehicle for transmitting signals to a transceiver apparatus. According to the invention, the antenna is characterized in that the resonant element is essentially composed of at least one shaped element made of metallic material and connected, in a circuit arrangement, to the transceiver apparatus and at least one metallic conductor which is helically wound and electrically connected at the bottom to the shaped element.

[0023] As a result of this antenna it is possible to satisfy the requirement for transmission in several telephone bands by means of low-cost product with extremely compact dimensions.

Brief description of the drawings

[0024] Further features and advantages of the invention will appear more clearly with reference to the detailed description of several preferred, but not exclusive, embodiments according to the invention, illustrated by way of a non-limiting example with the aid of the accompanying plates of drawings, in which:

FIG. 1 shows a first perspective view of the compact antenna for vehicles according to the present invention;

FIG. 2 shows a side view of the antenna in question;

FIG. 3 shows a front view of the antenna in question;

FIG. 4 shows a plan view of the antenna in question;

FIG. 5 shows a circuitry logic diagram of the antenna according to Fig. 1.

Detailed description of a preferred example of embodiment

[0025] With reference to the accompanying drawings, 1 denotes in its entirety the compact antenna for vehicles according to the present invention.

[0026] It is designed to be installed advantageously on any type of vehicle and, in particular, on vehicles for road travel such as, for example, motor cars, lorries, articulated lorries or the like.

[0027] In accordance with the present invention, the antenna 1 is devoid of a removable rod and is composed, as illustrated in Figs. 1-5, exclusively of a fixed part mounted projecting on the bodywork of the vehicle.

[0028] The abovementioned antenna 1 is advantageously used to allow operation of transceiver equipment such as, for example, cellular phones operating in various frequency bands.

[0029] As will be clarified below, said antenna does not require the use of active components such as signal amplifiers or modulators and allows resonance to be achieved as well as transmission with passbands which are sufficiently wide despite having extremely small dimensions.

[0030] In particular, the antenna 1 is intended to operate both in a frequency band of 900 MHz and in a frequency band of 1800 MHz, i.e. in both the bands commonly used in mobile phones.

[0031] Obviously, without departing from the scope of protection of the present invention, the antenna in question may be used for operation in a single frequency band or in several frequency bands also different from those mentioned above, since, by means of simple correction of the dimensions of the antenna components, it is possible to achieve resonance at different frequencies while using the same inventive idea.

[0032] According to the invention, the antenna 1 comprises a resonant element 2 composed of a shaped element 3 made of metallic material and connected in a circuit arrangement to the transceiver equipment 4 (such as, in particular, a mobile phone) and a metallic conductor 5 which is helically wound and connected at the bottom electrically to the shaped element 3.

[0033] In accordance with a preferred embodiment of the present invention, the shaped element 3 consists of a metallised portion with an elongated shape formed on a support for electronic circuits traditionally realised as a printed circuit.

[0034] Obviously, the shaped metallic element 3 may also assume other constructional forms different from that mentioned above, such as, for example, the form of a tube or a metal plate, without thereby departing from the scope of protection of the present invention.

[0035] Advantageously, the shaped metallic element 3 will be provided with a cross-section, with respect to its main extension, having a perimetral contour with a substantially large extension compared to the area of the said cross-section.

[0036] Owing to connection of a conductor 5 wound in manner of spring around a shaped element 3, on the one hand, the height required for resonance may be reduced, in particular for the low-frequency band at 900 MHz, while on the other hand the width of the passband during transmission of the signals is not adversely affected.

[0037] In the case, for example, of transceiver equipment 4 consisting of cellular phones operating in the bands of 900 MHz and 1800 MHz, as a result of the resonance element 2 it is possible, firstly, to obtain resonance at 900 MHz with a real height H of the resonant element 2 less than that envisaged for $\lambda/4$ and, secondly, to ensure in all cases optimum transmission of the signals also in the higher band of 1800 MHz.

[0038] Advantageously, therefore, according to the invention, owing to the configuration of the resonant element 2 divided into two differently shaped parts, it is possible to achieve resonance at 900 MHz with a height less than that envisaged for operation at $\lambda/4$. Moreover, the antenna 1 according to the present invention, if the spring conductor 5 is regarded as a single block, at the same time also achieves resonance transmission for the band of 1800 MHz. The total height H obtained by the sum of the height H' of the shaped element 3 and the height H" of the spring conductor 5 corresponds therefore to the length of $\lambda/4$ for operation at 1800 MHz, i.e. to about 4 cm.

[0039] It should be noted that the width of the spirals 5' of the spring allows the passband to be widened at 900 MHz, with the advantages of improved signal transmission and a reduction in reflection losses.

[0040] Preferably, moreover, the metallic conductor 5 is wound helically around an upper non-metallised portion 7 of the printed circuit 6, made of a dielectric material able to ensure a charging effect, while ensuring in all cases a low signal transmission loss factor.

[0041] The abovementioned upper portion 7 may also perform the function of a mechanical support for the helically wound conductor 5.

[0042] It is entirely obvious that the form and dimensions of the resonant element 2, as described above, play a decisive part in achieving the desired electrical characteristics.

[0043] In fact, even small variations in the cross-section or in the length of the metallic conductor 5 or in the form of its spirals may result in a significant variation in the electrical behaviour of the antenna and, for example, in imperfect transmission resonance in both the bands of 900 MHz and 1800 MHz.

[0044] It is therefore extremely important that the production process should be able to ensure the manufacture of all the components to within very small tolerances. Obviously, the said production process must at the same time be entirely automated so as to be convenient from a cost point of view.

[0045] As is known, the machines used in traditional spring-manufacturing plants are able to form a metal wire into a spring with spirals of the desired shape in a sufficiently precise manner and with sufficiently small tolerances (for example less than one tenth of a mm).

[0046] On the other hand, however, the same machinery designed for production of the springs ensure a similar precision in cutting of the free end 15 only if the latter is envisaged as projecting from the spirals of the conductor 5 in a displaced position, able to allow easy cutting thereof from the remainder of the conductor using a special tool.

[0047] Owing to the particular requirements of keeping the maximum height H of the antenna within predefined limits, as already mentioned above, the free end 15 must extend preferably in the horizontal direction rather than in the vertical direction.

[0048] A particularly advantageous constructional solution is thus shown in the accompanying Figs. 1 and 2, where it is envisaged that the free end 15 of the metallic conductor element 5 extends horizontally at least partially outside of the perimeter defined by the helix.

[0049] Obviously, when determining the overall electrical characteristics of the resonance element 2, it is important to take into account also the form and position of the end 15 of the metallic conductor 5.

[0050] In other words, it is thus envisaged that the antenna part represented by the helically wound conductor 5 may be produced by means of an industrial process which, while being entirely automatic and therefore ultimately relatively inexpensive, at the same time is sufficiently precise to ensure the tolerances necessary for optimum electrical operation.

[0051] In order to widen further the passband without, however, introducing either active elements or components which may result in losses arising during signal transmission (power loss), a match circuit 8 may be advantageously used, said circuit being composed, for example, of two inductances 9 arranged in series and connected, on the one hand, to the antenna cable 10 and, on the other hand, to the base 11 of the shaped element 3 and separated by a capacitance 12 connected to earth (see Fig. 6).

[0052] In accordance with a preferred embodiment of the present invention, the match circuit is preferably provided in a second printed circuit 13 which is substantially horizontal and into which additional elements 14 of the active or passive type for other intended functions of the antenna 1, such as for example satellite navigation by means of a GPS system, may be introduced.

[0053] Functionally speaking, therefore, the compact antenna 1 described hitherto from a mainly structural point of view allows the operation, in particular without the use of active components, also for the low frequency bands available today on the market (and in particular for the 900 MHz band), by means of a particular form of the resonant element 2 which retains an extremely small height.

[0054] Moreover, the same antenna 1 is designed to be used advantageously in association with the cellular phones which are available today on the market and which use two different transmission bands (900 MHz and 1800 MHz).

[0055] For this purpose, it has an overall height of λ/4 equivalent to resonance operation in the higher band of 1800 MHz.

[0056] According to the invention, the antenna in question offers the advantage, in the examples of embodiment illustrated above, of having an extremely compact form, a low production cost and optimum performance characteristics both at the low frequencies (900 MHz) and at the high frequencies (1800 MHz) in particular without the use of active components.

[0057] More particularly, the antenna in question is advantageously designed for resonance operation in the bands of 900 MHz and 1800 MHz used by mobile phones commercially available nowadays, without the need for introducing active circuit components. The height H of the resonant element 2 is of substantial importance for determining the operation of the antenna 1 in the higher band, while its form is decisive for operation of the antenna 1 in the lower band.

[0058] The invention thus conceived therefore achieves the predefined objects.

[0059] Obviously it may assume, in its practical embodiment, also forms and configurations different from that illustrated above without, thereby, departing from the present scope of protection.

[0060] Moreover, all the details may be replaced by technically equivalent elements and the dimensions, the forms and the materials used may be of any kind, in accordance with requirements.

Claims

1. Compact antenna for vehicles of the type comprising at least one resonant element (2) extending in a projecting manner from said vehicle for transmitting signals to a transceiver apparatus (4), **characterized in that** said resonant element (2) is substantially composed of: - at least one shaped element (3) made of metallic material and connected in a circuit arrangement to said transceiver apparatus (4); - and at least one helically wound metallic conductor (5) which has a free end and is electrically connected at the bottom to said shaped element (3).

2. Vehicle antenna according to Claim 1, **characterized in that** said metallic conductor element (5) has a free end (15) which extends at least partially projecting outside of the perimeter defined by the helix thereof.

3. Vehicle antenna according to Claim 1, **characterized in that** said shaped element (3) is formed on a support for electronic circuits (6).

4. Vehicle antenna according to Claim 3, **characterized in that** said support for electronic circuits consists of a printed circuit (6) and **in that** said shaped element (3) consists of a metallised portion of said printed circuit (6).

5. Vehicle antenna according to Claim 4, **characterized in that** said metallised portion of said printed circuit (6) has an elongated form.

6. Vehicle antenna according to Claim 1, **characterized in that** said shaped element (3) consists of a tube or a metal plate with an elongated form.

7. Vehicle antenna according to Claim 3, **characterized in that** said metallic conductor (5) is helically wound around an upper portion (7) of said support for electronic circuits (6).

8. Vehicle antenna according to Claim 3, **characterized in that** said metallic conductor (5) is helically wound around a dielectric element (7) mounted above said support for electronic circuits (6).

9. Vehicle antenna according to Claim 7, **characterized in that** said metallic conductor (5) is mechanically supported by the upper portion (7) of said support for electronic circuits (6).

10. Vehicle antenna according to Claim 1, **characterized in that** it comprises at least one impedance match circuit (8) electrically connected to the bottom end of said shaped element (3).

11. Vehicle antenna according to Claim 10, **characterized in that** said impedance match circuit (8) comprises at least two inductances (9) which are arranged in series and electrically connected to said shaped element (3) and an antenna cable (10), and a capacitance (12) connected to earth and electrically connected between the two inductances (9).

12. Vehicle antenna according to Claim 1, **characterized in that** said antenna (1) performs resonance transmission of signals for the frequency bands of 900 MHz and 1800 MHz.

13. Vehicle antenna according to Claim 1, **characterized in that** the overall height (H) of said resonant element (2) lies within the range of 3 and 4 cm.

14. Vehicle antenna according to Claim 1, **characterized in that** the overall height (H) of said resonant element (2) corresponds to the resonance length of λ/4 at the band frequency of 1800 MHz.

15. Vehicle antenna according to Claim 1, **characterized in that** said resonant element (2) is mounted substantially vertically on a second printed circuit (13), said resonant element (2) being arranged substantially vertically and said second printed circuit (13) being arranged substantially horizontally.

16. Vehicle antenna according to Claim 1, **characterized in that** said resonant element (2) is mounted fixed on the bodywork of said vehicle.

17. Vehicle antenna according to Claim 1, **characterized in that** said shaped element (3) has a cross-section with a perimetral contour having an extension which is substantially large compared to the area of said cross-section.

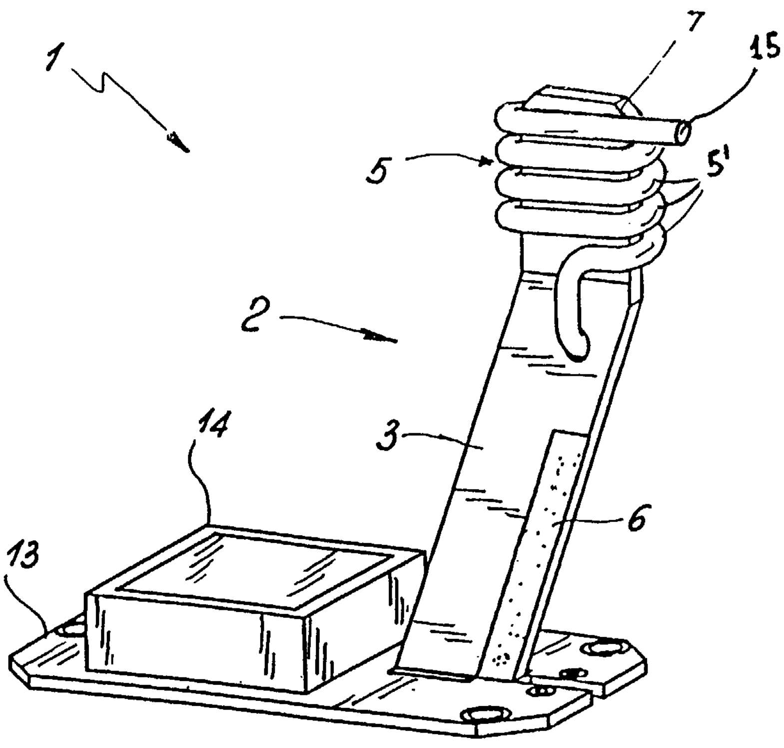

Fig. 1

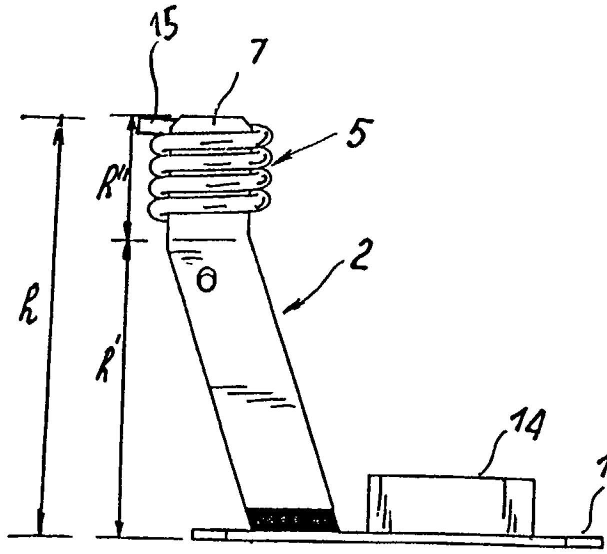

Fig. 2

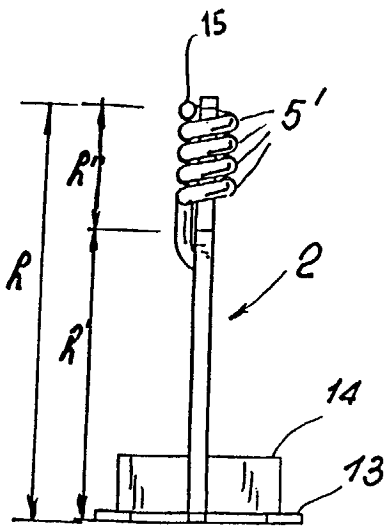

Fig. 3

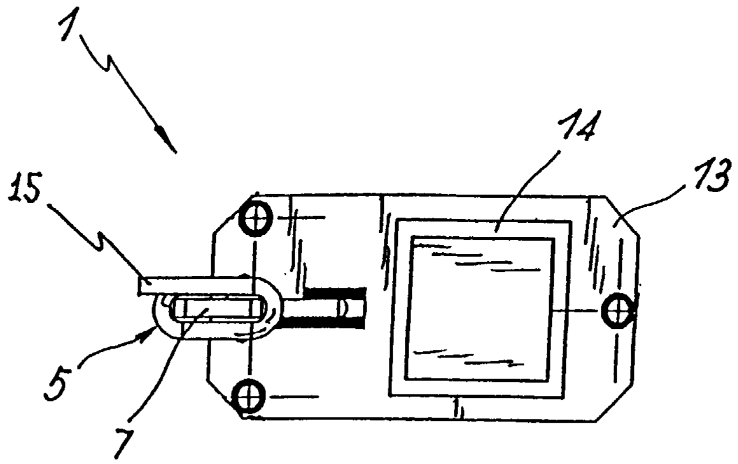

Fig. 4

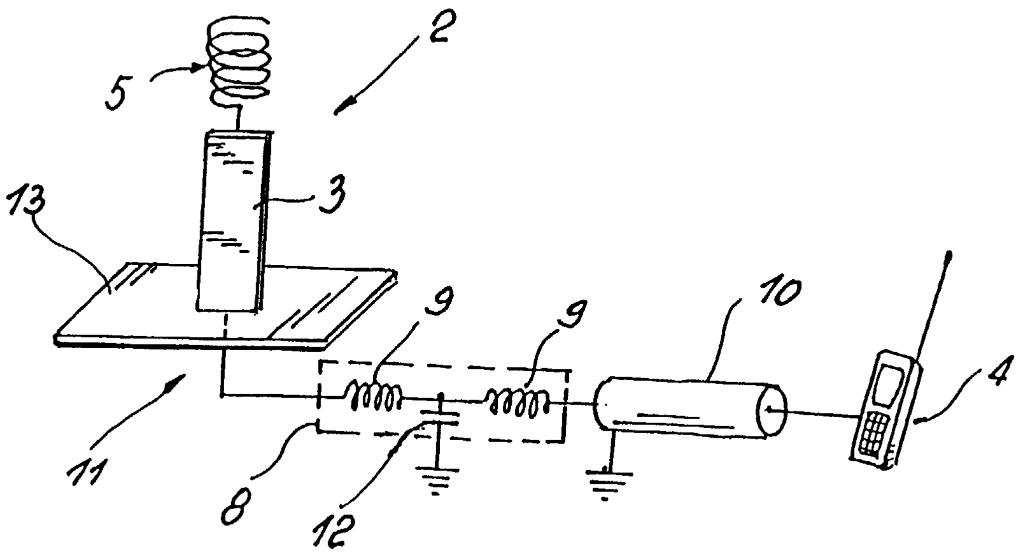

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 02 00 1222

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 0 896 384 A (TOKIN CORP) 10 February 1999 (1999-02-10) * page 2, line 9 - line 10 * * page 4, line 40 - page 5, line 8 * * figure 5 *	1-17	H01Q9/36 H01Q1/36 H01Q5/00
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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

H01Q

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	26 April 2002	Dollinger, F

CATEGORY OF CITED DOCUMENTS

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