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(54) **MULTIFREQUENCY MICROSTRIP PATCH ANTENNA WITH PARASITIC COUPLED ELEMENTS**

MEHRFREQUENZ-MIKROSTREIFEN-PATCH-ANTENNE MIT PARASITÄR GEKOPPELTEN ELEMENTEN

ANTENNE A PLAQUE MICRORUBAN MULTIFREQUENCE AVEC ELEMENTS COUPLES NON ALIMENTES

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Description

OBJECT AND BACKGROUND OF THE INVENTION

[0001] The present invention refers to a new class of microstrip antennas with a multifrequency behaviour based on stacking several parasitic patches underneath an active upper patch.

[0002] An antenna is said to be multifrequency when the radioelectrical performance (impedance, polarization, pattern, etc.) is invariant for different operating frequencies. The concept of multifrequency antennas derives of frequency independent antennas. Frequency independent antennas were first proposed by V.H.Rumsey *(*V.H.Rumsey, "Frequency Independent Antennas", 1957 IRE National Convention Record, pt.1, pp. 114-118*)* and can be defined as a family of antennas whose performance (impedance, polarization, pattern...) remains the same for any operating frequency. Rumsey work led to the development of the log-periodic antenna and the log-periodic array. Different groups of independent antennas can be found in the literature as the self-scalable antennas based directly in Rumseys Principle as spiral antennas (J.D.Dyson, "The Unidirectional Equiangular Spiral Antenna", IRE Trans. Antennas Propagation, vol. AP-7, pp.181-187, October 1959) and self-complementary antennas based on Babinet's Principle. This principle was extended later on by Y.Mushiake in 1948.

[0003] An analogous set of antennas are multifrequency antennas where the antenna behaviour is the same but at a discrete set of frequencies. Multilevel antennas such as those described in Patent Publication No. WO01/22528 *"Multilevel Antennas*" are an example of a kind of antennas which due to their geometry they behave in a similar way at several frequency bands, that is, they feature a multifrequency (multiband) behavior.

[0004] In this case, the concept of multifrequency antennas is applied in an innovative way to microstrip antennas, obtaining this way a new generation of multifrequency microstrip patch antennas. The multifrequency behaviour is obtained by means of parasitic microstrip patches placed at different heights under the active patch. Some of the advantages of microstrip patch antennas with respect to other antenna configurations are: lightweight, low volume, low profile, simplicity and, low fabrication cost.

[0005] Some attempts to design microstrip patch antennas appear in the literature by means of adding several parasitic patches in a two dimensional, co-planar configuration (F.Croq, D.M.Pozar, "Multifrequency Operation of Microstrip Antennas Using Aperture Coupled Parallel Resonators'', IEEE Transactions on Antennas and Propagation, vol.40, n°11, pp.1367-1374, Nov. 1992). Also, several examples of broadband or multiband antennas consisting on a set of parasitic layers on top of an active patch are described in the literature (see for instance J.Anguera. C.Puente, C.Borja, "A Procedure to Design Stacked Microstrip Patch Antennas Based on a Simple Network Model", Microwave and Opt. Tech. Letters, Vol.30, no.3, Wiley, June, 2001); however it should be stressed that in that case the parasitic layers are placed on top of the fed patch (the active patch), while in the present invention the patches are placed underneath said active patch, yielding to a more compact and mechanically stable design with yet still featuring a multiband or broadband behavior.

[0006] M. SANAD, "A COMPACT DUAL-BROADBAND MICROSTRIP ANTENNA HAVING BOTH STACKED AND PLANAR PARASITIC ELEMENTS", IEEE ANTENNAS AND PROPAGATION SOCIETY INERNATIONAL SYMPOSIUM 1996 DIGEST, JULY 21-26, 1996, HELD IN CONJUNCTION WITH THE USNC/URSI NATIONAL RADIO. SCIENCE MEETING, NEW YORK, IEEE, US, vol. 1, 21 July 1996, pages 6-9, discloses an arrangement substantially in line with the preamble of claim 1.

[0007] It is interesting noticing that any of the patch geometries described in the prior art can be used in an innovative way for either the active or parasitic patches disclosed in the present invention. An example of prior art geometries are square, circular, rectangular, triangular, hexagonal, octagonal, fractal, space-filling *("Space-Filling Miniature Antennas",* Patent Publication No. WO01/54225) or again, said Multilevel geometries (WO01/22528).

[0008] On the other hand, an Space-Filling Curve (hereafter SFC) is a curve that is large in terms of physical length but small in terms of the area in which the curve can be included. More precisely, the following definition is taken in this document for a space-filling curve: a curve composed by at least ten segments which are connected in such a way that each segment forms an angle with their neighbours, that is, no pair of adjacent segments define a larger straight segment, and wherein the curve can be optionally periodic along a fixed straight direction of space if, and only if, the period is defined by a non-periodic curve composed by at least ten connected segments and no pair of said adjacent and connected segments defines a straight longer segment. Also, whatever the design of such SFC is, it can never intersect with itself at any point except the initial and final point (that is, the whole curve can be arranged as a closed curve or loop, but none of the parts of the curve can become a closed loop). A space-filling curve can be fitted over a flat or curved surface, and due to the angles between segments, the physical length of the curve is always larger than that of any straight line that can be fitted in the same area (surface) as said space-filling curve. Additionally, to properly shape the ground-plane according to the present invention, the segments of the SFC curves included in said ground-plane must be shorter than a tenth of the free-space operating wavelength.

SUMMARY OF THE INVENTION

[0009] One of the main features of the present invention is the performance of the design as a multifrequency microstrip patch antenna. The proposed antenna is based on an active microstrip patch antenna and at least two parasitic patches are placed underneath the active patch, in the space between said upper patch and the ground-plane or ground-counterpoise. The spacing among patches can be filled with air or for instance with a dielectric material to provide compact mechanical design. One or more feeding sources can be used to excite the said active patch to obtain dual polarized or circular polarized antenna. The feeding mechanism of said active patch can be for example a coaxial line attached to the active patch. Any of the well known matching networks and feeding means described in the prior art (for instance gap or slot coupled structures, 'L-shaped' probes or coaxial lines) can be also used. Due to its structure, the antenna is able to operate simultaneously at several frequency bands of operation having each band excellent values of return losses (from -6dB to -60 dB depending on the application) and similar radiation patterns throughout all the bands.

[0010] The advantage of this novel antenna configuration with respecto to the prior art is two-fold. On one hand, the invention provides a compact and robust mechanical design, with a low-profile compared to other prior art stacked configurations, and with a single feed for all frequencies. On the other hand, the inclusion of many resonant elements, i.e. the parasitic patches, that can be tunned individual provides a high degree of freedom in tayloring the antenna frequency response to a multiband or broadband behavior. This way, the antenna device finds place in many applications where the integration of multiple wireless services (such as for instance AMPS, GSM900, GSM1800, PCS1899, CDMA, UMTS, Bluetooth, TACS, ETACS, DECT, Radio FM/AM, DAB, GPS) into a single antenna device is required.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

Figure1.- Shows an active patch fed by a coaxial probe and six parasitic patches placed underneath the said active patch.

Figure.2.- As Fig.1 but in this case the active patch is fed by a coaxial probe and a capacitor etched on the same surface where the active patch is etched.

Figure.3.- As Fig.1 but in this case the active patch is fed by a coaxial probe and a capacitor under the active patch.

Figure.4 As Fig.1 but in this case the active patch is fed by a L-shaped coaxial probe.

Figure.5 Shows a square-shaped active patch and several parasitic patches based on a particular example of multilevel geometry.

Figure.6 As Fig.5 but in this case the patches are based on a particular example of space-filling geometry.

Figure.7 Shows a top view of the feeding point on the active patch. Two probe feeds are used to achieve a dual-polarized or circular-polarized antenna.

Figure.8 As Fig.1 but in this case several layer of different dielectric are used between the radiating elements.

Figure.9 Shows an arrangement where the active and parasitic patches are non-aligned , that is, the centre of each element does not lie on the same axis.

DETAILED DESCRIPTION OF SOME PREFERRED EMBODIMENTS OF THE INVENTION

[0012] Fig.1 describes a preferred embodiment of the multifrequency microstrip patch antenna formed by an active patch (1) fed by a coaxial probe (3) and several parasitic patches (2) placed underneath the said active patch (1). Either the active patch (1) and parasitic patches (2) can be for instance printed, over a dielectric substrate or, alternatively they can be conformed through a laser process. In general, any of the well-known printed circuit fabrication or other prior art techniques for microstrip patch antennas can be applied to physically implement the patches and do not constitute an essential part of the invention. In some preferred embodiments, said dielectric substrate is a glass-fibre board (FR4), a Teflon based substrate (such as Cuclad®) or other standard radiofrequency and microwave substrates (such as for instance Rogers 4003® or Kapton®). The dielectric substrate can even be a portion of a window glass if the antenna is to be mounted in a motor vehicle such as a car, a train or an airplane, to transmit or receive electromagnetic ways associated to, for instance, some telecommunications systems such as radio, TV, cellular telephone (GSM 900, GSM 1800, UMTS) or satellite applications (GPS, Sirius and so on). Due to the multifrequency nature of the antenna, all these systems, some of them, or a combination of some of them with other telecommunications systems can operate simultaneously through the antenna described in the present invention. Of course, a matching, filtering or amplifying network (to name some examples) can be connected or integrated at the input terminals of the active patch (1).

[0013] The said active (1) patch feeding scheme can be taken to be any of the well-known schemes used in prior art patch antennas for instance: coaxial probe (3) as shown in Fig.1, coaxial probe (3) and capacitor (5) as shown in figures 2,3, L-shaped coaxial probe (3') as shown in figure.4" or slot fed probe. In the case of the probe-feeding scheme, the pin, wire or post of the feeding probe crosses all parasitic patches (2) through an aperture at each of said parasitic patches. When the antenna is fed by means of a microstrip line underneath the ground-plane (4), a slot on said ground-plane (4) and on each of the individual parasitic patches (2) provides a mean to feed the upper active patch (1). It would be apparent to those skilled in the art that clear that, whatever the feeding mechanism is, two feeding ports (8) shown in Figure 7, can be used in order to obtain a dual polarized, slant polarized, elliptical polarized or circular polarized antenna.

[0014] The medium between the active and parasitic elements can be air, foam or any standard radio frequency and microwave substrate. Moreover, several different dielectric layers (9) can be used, for instance: the patches can be etched on a rigid substrate such as Rogers 4003® or fibber glass and soft foam can be introduced to separate the elements (Fig.8).

[0015] Dimensions of either active (1) or parasitic patches (2) are adjusted in order to obtain the desired multifrequency operation. Typically, patches have: a size between a quarter wavelength and a full-wavelength on the desired operating frequency band. When a short-circuit is included in for instance one of the patches, then the size of the said patch can be reduced below a quarter wavelength. In the case of space-filling perimeter patches, the size of the patch can be made larger than a full-wavelength if the operation through a high-directivity high-order mode is desired. Patch shapes and dimensions can be different in order to obtain such multifrequency operation and to obtain a compact antenna. For instance, dimensions of patches can be further reduced using space-filling (7) or a multilevel geometry (6). This reduction process can be applied to the whole structure or only to some elements (Fig.5 and 6). Also, in some embodiments, the multiband behavior of said multilevel or space-filling geometries can be used in combination with the multiband effect of the multilayer structure of the present invention to enhance the performance of the antenna.

[0016] The active and parasitic patch centres can be non-aligned in order to achieve the desired multifrequency operation. This non-alignment can be in the horizontal, vertical or both axis (Fig.9) and provides a useful way of tuning the band of the antenna while adjusting the impedance and shaping the resulting antenna pattern.

[0017] It is clear to those skilled in the art, that the multiband behavior featured by the antenna device disclosed in the present invention will be of most interest in those environments such as for instance, base-station antennas in wireless cellular systems, automotive industry, terminal and handset industry, wherein the simultaneous operation of several telecommunication systems through a single antenna is an advantage. An antenna device like the one described in the present invention can be used, for instance, to operate simultaneously at a combination of some of the frequency bands associated with AMPS, GSM900, GSM1800, PCS1899, CDMA, UMTS, Bluetooth, TACS, ETACS, DECT, Radio FM/AM, DAB, GPS or in general, any other radiofrequency wireless system.

Claims

1. A multifrequency microstrip patch antenna device including a ground-plane or ground-counterpoise and a first conducting layer, said conducting layer acting as the active patch for the whole antenna device, said active patch being fed at least at a point of said conducting layer, **characterised in that** said microstrip patch antenna comprises at least two additional conducting layers acting as parasitic patches (2), said parasitic patches being placed underneath said first active patch, at different levels between said active patch and said ground-plane or ground-counterpoise wherein at least one of the parasitic patches includes a multilevel structure or a space-filling structure or a combination of them, and/or wherein at least hje active patch includes a multilevel structure, a space-filling structure or a combination of them.

2. A microstrip patch antenna device according to claim 1, wherein at least one of the parasitic patches includes a multilevel structure.

3. A microstrip patch antenna device according to claim 1 or 2, wherein at least one of the parasitic patches includes a space-fitting structure.

4. A microstrip patch antenna device according to claim 1 or three wherein at least the active patch includes a multilevel structure, a space-filling structure or a combination of them.

5. A microstrip patch antenna device according to claims 1 or 4 wherein the active patch geometry is selected from the group consisting of: square, circular, rectangular, triangular, hexagonal, octagonal and fractal.

6. A microstrip patch antenna device according to any of the claim 1 to 3 wherein the parasitic patches geometry is selected from the group consisting of: square, circular, rectangular, triangular, hexagonal, octagonal and fractal.

7. A microstrip patch antenna device according to any of the preceding claims wherein the active patch and the parasitic patches have different shapes and dimensions.

8. A microstrip patch antenna device according to any of the preceding claims wherein the antenna features a multiband behavior at as many bands as patch layers in the antenna arrangement.

9. A microstrip patch antenna device according to any of the claims 1 to 4 wherein the antenna features a broadband behavior.

10. A microstrip patch antenna device according to any of the claims 1 to 6 wherein said antenna is used to operate simultaneously for several communication systems.

11. A microstrip patch antenna device according claims 1 to 7 wherein the antenna is fed at the active patch at two feeding points to provide dual polarization, slant polarization, circular polarization, elliptical polarization or a combination of them.

12. A microstrip patch antenna device according claims 1 to 8 wherein at least one of the patches is larger than the operating wavelength and at least a portion of the perimeter of said patch is an space-filling curve and the antenna is operated at a localized resonating mode of order larger than one for said particular patch.

13. A microstrip patch antenna device according any of the preceding claims wherein the area covered by the antenna is smaller than the one covered by a conventional patch with the same bandwidth.

14. A microstrip patch antenna device according any of the preceding claims wherein the centre of at least one patch is non-aligned with a vertical axis orthogonally crossing the active patch at its centroid.

15. A microstrip patch antenna device according to any of the preceding claims wherein at least one patch is not horizontally aligned with respect to the other patches.

16. A microstrip patch antenna device according claims 1 to 11 wherein the antenna is fed by means of at least a conducting pin, wire or post, said pin wire or post crossing all the layers through an aperture at each of the parasitic patches , said pin, wire or post been electromagnetically coupled to the active patch either by means of ohmic contact or capacitive coupling.

17. A microstrip patch antenna device according claims 1 to 11 wherein the antenna is fed by means of microship line, said microstrip line being placed underneath the ground-plane and coupled to the upper patch by means of an slot on each individual parasitic patch and on the ground-plane.

18. A microstrip patch antenna device according to any of the preceding claims, wherein the active and the parasitic patches are printed over a dielectric substrate.

19. A microstrip patch antenna device according to claim 15 wherein one of said dielectric substrate is a portion of a window glass of a motor vehicle.

20. A microstrip patch antenna device according to any of the preceding claims, wherein the antenna device operates simultaneously at a combination of frequency bands selected from the group : AMP, GSM900, GSM1800, PCS1899, CDMA, UMTS, Bluetooth, TACS, ETACS, DECT, Radio FM/AM, GPS, or any other radiofrequency wireless system.

21. A microstrip patch antenna device according to any of the preceding claims, wherein one of said patches (1, 2) is short-circuited to the ground-plane (4).

22. A microstrip patch antenna device according to any of claims 1-20, wherein none of said patches (1, 2) is short-circuited to the ground-plane (4).

Patentansprüche

1. Multifrequenz- Mikrostreifen- Patchantennengerät (Patch - Flicken) einschließlich einer Masseplatte (4) und eines Massegegengewichtes und einer ersten leitenden Schicht, wobei die erste leitende Schicht als der aktive Patch für das gesamte Antennengerät agiert, der zumindest an einem Punkt der leitenden Schicht gespeist wird, wobei die Mikrostreifen-Patchantenne zumindest zwei zusätzliche leitende Schichten umfasst, die als parasitäre Patches (2) agieren, wobei die parasitären Patches unter dem ersten aktiven Patch bei unterschiedlichen Leveln zwischen dem ersten aktiven Patch und der Masseplatte oder dem Massegegengewicht angeordnet sind,
dadurch gekennzeichnet, dass
zumindest einer der parasitären Patches eine Multilevelstruktur oder eine Raum-füllende Struktur oder eine Kombination aus diesen einschließt, und/oder wobei zumindest der aktive Patch eine Multilevelstruktur, eine Raum-füllende Struktur oder eine Kombination aus diesen einschließt.

2. Mikrostreifen-Patchantennengerät nach Anspruch 1, wobei zumindest einer der parasitären Patches eine Multilevelstruktur einschließt.

3. Mikrostreifen-Patchantennengerät nach Anspruch 1 oder 2, wobei zumindest einer der parasitären Patches eine Raum-füllende Struktur einschließt.

4. Mikrostreifen-Patchantennengerät nach Anspruch 1 oder 3, wobei zumindest der aktive Patch eine Multilevelstruktur, eine Raum-füllende Struktur oder eine Kombination aus diesen einschließt.

5. Mikrostreifen-Patchantennengerät nach Anspruch 1 oder 4, die Geometrie des aktiven Patch aus der Gruppe ausgewählt wird, die besteht aus: quadratisch, kreisförmig, rechteckig, dreieckig, sechseckig, achteckig und fraktal.

6. Mikrostreifen-Patchantennengerät nach einem der Ansprüche 1 bis 3, wobei die Geometrie des parasitären Patch aus der Gruppe ausgewählt wird, die besteht aus: quadratisch, kreisförmig, rechteckig, dreieckig, sechsekkig, achteckig und fraktal.

7. Mikrostreifen-Patchantennengerät nach einem der vorangehenden Ansprüche, wobei der aktive Patch und der parasitäre Patch unterschiedliche Formen und Abmessungen aufweisen.

8. Mikrostreifen-Patchantennengerät nach einem der vorangehenden Ansprüche, wobei die Antenne ein Multiband-Verhalten bei so vielen Bändern wie Patch-Schichten in der Antennenanordnung aufweist.

9. Mikrostreifen-Patchantennengerät nach einem der Ansprüche 1 bis 4, wobei die Antenne ein Breitbandverhalten aufweist.

10. Mikrostreifen-Patchantennengerät nach Anspruch 1 bis 6, wobei die Antenne verwendet wird simultan für mehrere Kommunikationssysteme zu arbeiten.

11. Mikrostreifen-Patchantennengerät nach Anspruch 1 bis 7, wobei die Antenne bei dem aktiven Patch bei zwei Speisepunkten speist wird, um eine duale Polarisation, eine geneigte Polarisation, eine zirkulare Polarisation, eine elliptische Polarisation oder eine Kombination aus diesen bereit zu stellen.

12. Mikrostreifen-Patchantennengerät nach Anspruch 1 bis 8, wobei zumindest einer der Patches größer als die Betriebswellenlänge ist und zumindest ein Teil des Umfangs des Patch eine Raum-füllende Kurve ist und die Antenne bei einer lokalisierten Resonanzmode einer Ordnung betrieben wird, die größer als diejenige für den bestimmten Patch ist.

13. Mikrostreifen-Patchantennengerät nach einem der vorangehenden Ansprüche, wobei der Bereich, der von der Antenne abgedeckt wird, kleiner ist als derjenige, der von einem herkömmlichen Patch mit der gleichen Bandbreite abgedeckt wird.

14. Mikrostreifen-Patchantennengerät nach einem der vorangehenden Ansprüche, wobei das Zentrum zumindest eines Patches nicht-ausgerichtet zu einer vertikalen Achse ist, die den aktiven Patch bei seinem Schwerpunkt orthogonal kreuzt.

15. Mikrostreifen-Patchantennengerät nach einem der vorangehenden Ansprüche, wobei zumindest ein Patch nicht horizontal bezüglich der anderen Patches ausgerichtet ist.

16. Mikrostreifen-Patchantennengerät nach Anspruch 1 bis 11, wobei die Antenne mittels zumindest einem leitenden Stift, Draht oder Stab gespeist wird, wobei der Stift, Draht oder Stab alle Schichten durch eine Öffnung bei jedem der parasitären Patches kreuzt, wobei der Stift, Draht oder Stab elektromagnetisch mit dem aktiven Patch entweder mittels eines ohmschen Kontaktes oder einer kapazitiven Kopplung gekoppelt ist.

17. Mikrostreifen-Patchantennengerät nach Anspruch 1 bis 11, wobei die Antenne mittels einer Mikrostreifenleitung gespeist wird, wobei die Mikrostreifenleitung unter der Masseplatte angeordnet ist und mit dem oberen Patch mittels eines Schlitzes auf jedem einzelnen parasitären Patch und auf der Masseplatte gekoppelt ist.

18. Mikrostreifen-Patchantennengerät nach einem der vorangehenden Ansprüche, wobei die aktiven und parasitären Patches auf einem dielektrischen Substrat gedruckt sind.

19. Mikrostreifen-Patchantennengerät nach Anspruch 15, wobei eines des dielektrischen Substrates ein Teil eines Fensterglases eines Motorfahrzeugs ist.

20. Mikrostreifen-Patchantennengerät nach einem der vorangehenden Ansprüche, wobei das Antennegerät simultan bei einer Kombination von Frequenzbändern arbeitet, die aus der Gruppe ausgewählt sind: AMP, GSM900, GSM1800, CDMA, UMTS, Bluetooth, TACS, ETACS, DECT, Funk-FM/AM (Radio AM/FM), GPS oder irgendein anderes drahtloses Funkfrequenzsystem.

21. Mikrostreifen-Patchantennengerät nach einem der vorangehenden Ansprüche, wobei zumindest einer der Patches (1,2) mit der Masseplatte (4) kurzgeschlossen ist.

22. Mikrostreifen-Patchantennengerät nach einem der Ansprüche 1-20, wobei keiner der Patches (1,2) mit der Masseplatte (4) kurzgeschlossen ist.

Revendications

1. Dispositif d'antenne à plaques microruban multi-fréquence comprenant un plan de sol (4) ou un contrepoids de sol et une première couche conductrice, ladite couche conductrice agissant comme la plaque active de l'ensemble du dispositif d'antenne, ladite plaque active (1) étant alimentée au moins à un point de ladite couche conductrice, **caractérisé en ce que** ladite antenne à plaques microruban comprend au moins deux couches conductrices supplémentaires agissant comme des plaques parasites (2), lesdites plaques parasites étant placées en dessous de ladite première plaque active, à différents niveaux entre ladite plaque active et ledit plan de sol ou contrepoids de sol, dans lequel au moins une des plaques parasites comprend une structure multiniveaux ou une structure de remplissage d'espace ou une combinaison de celles-ci, et/ou dans lequel au moins la plaque active comprend une structure multiniveaux, une structure de remplissage d'espace ou une combinaison de celles-ci.

2. Dispositif d'antenne à plaques microruban selon la revendication 1, dans lequel au moins une des plaques parasites comprend une structure multiniveaux.

3. Dispositif d'antenne à plaques microruban selon la revendication 1 ou 2, dans lequel au moins une des plaques parasites comprend une structure de remplissage d'espace.

4. Dispositif d'antenne à plaques microruban selon la revendication 1 ou 3, dans lequel au moins la plaque active comprend une structure multiniveaux, une structure de remplissage d'espace ou une combinaison de celles-ci.

5. Dispositif d'antenne à plaques microruban selon les revendications 1 ou 4, dans lequel la géométrie de la plaque active est choisie dans le groupe comprenant : carrée, circulaire, rectangulaire, triangulaire, hexagonale, octogonale et fractale.

6. Dispositif d'antenne à plaques microruban selon l'une quelconque des revendications 1 à 3, dans lequel la géométrie des plaques parasites est choisie dans le groupe comprenant: carrée, circulaire, rectangulaire, triangulaire, hexagonale, octogonale et fractale.

7. Dispositif d'antenne à plaques microruban selon l'une quelconque des revendications précédentes, dans lequel la plaque active et les plaques parasites ont des formes et dimensions différentes.

8. Dispositif d'antenne à plaques microruban selon l'une quelconque des revendications précédentes, dans lequel l'antenne présente un comportement multibande à autant de bandes que de couches de plaques dans l'agencement d'antenne.

9. Dispositif d'antenne à plaques microruban selon l'une quelconque des revendications 1 à 4, dans lequel l'antenne présente un comportement large bande.

10. Dispositif d'antenne à plaques microruban selon l'une quelconque des revendications 1 à 6, dans lequel ladite antenne est utilisée pour fonctionner simultanément dans plusieurs systèmes de communication.

11. Dispositif d'antenne à plaques microruban selon les revendications 1 à 7, dans lequel l'antenne est alimentée au niveau de la plaque active en deux points d'alimentation pour fournir une double polarisation, une polarisation oblique, une polarisation circulaire, une polarisation elliptique ou une combinaison de celles-ci.

12. Dispositif d'antenne à plaques microruban selon les revendications 1 à 8, dans lequel au moins une des plaques est plus grande que la longueur d'onde opérationnelle et au moins une partie du périmètre de ladite plaque est une courbe de remplissage d'espace et l'antenne fonctionne à un mode de résonance localisé d'un ordre supérieur à un pour ladite plaque particulière.

13. Dispositif d'antenne à plaques microruban selon l'une quelconque des revendications précédentes, dans lequel la zone couverte par l'antenne est plus petite que celle couverte par une plaque classique avec la même largeur de bande.

14. Dispositif d'antenne à plaques microruban selon l'une quelconque des revendications précédentes, dans lequel le centre d'au moins une plaque est non-aligné sur un axe vertical croisant de façon orthogonale la plaque active au niveau de son centre de gravité.

15. Dispositif d'antenne à plaques microruban selon l'une quelconque des revendications précédentes, dans lequel au moins une plaque n'est pas alignée horizontalement par rapport aux autres plaques.

16. Dispositif d'antenne à plaques microruban selon les revendications 1 à 11, dans lequel l'antenne est alimentée par au moins une broche, une borne ou un fil conducteur, ladite broche, ledit fil ou ladite borne croisant l'ensemble des couches à travers une ouverture au niveau de chacune des plaques parasites, ladite broche, ledit fil ou ladite borne étant couplé électro-magnétiquement à la plaque active, soit par un contact ohmique, soit par couplage capacitif.

17. Dispositif d'antenne à plaques microruban selon les revendications 1 à 11, dans lequel l'antenne est alimentée au moyen d'une ligne microruban, ladite ligne microruban étant placée en dessous du plan de sol et couplée à la plaque supérieure au moyen d'une fente sur chaque plaque parasite individuelle et sur le plan de sol.

18. Dispositif d'antenne à plaques microruban selon l'une quelconque des revendications précédentes, dans lequel les plaques actives et parasites sont imprimées sur un substrat diélectrique.

19. Dispositif d'antenne à plaques microruban selon la revendication 15, dans lequel un dit substrat diélectrique fait partie d'une vitre d'un véhicule à moteur.

20. Dispositif d'antenne à plaques microruban selon l'une quelconque des revendications précédentes, dans lequel le dispositif d'antenne fonctionne simultanément à une combinaison de bandes de fréquences choisies dans le groupe: AMP, GSM900, GSM1800, PCS1899, CDMA, UMTS, Bluetooth, TACS, ETACS, DECT, Radio FM/AM, GPS, ou tout autre système sans fil radiofréquence.

21. Dispositif d'antenne à plaques microruban selon l'une quelconque des revendications précédentes, dans lequel une desdites plaques (1, 2) est courtcircuitée au plan de sol (4).

22. Dispositif d'antenne à plaques microruban selon l'une quelconque des revendications 1 à 20, dans lequel aucune desdites plaques (1, 2) n'est courtcircuitée au plan de sol (4).

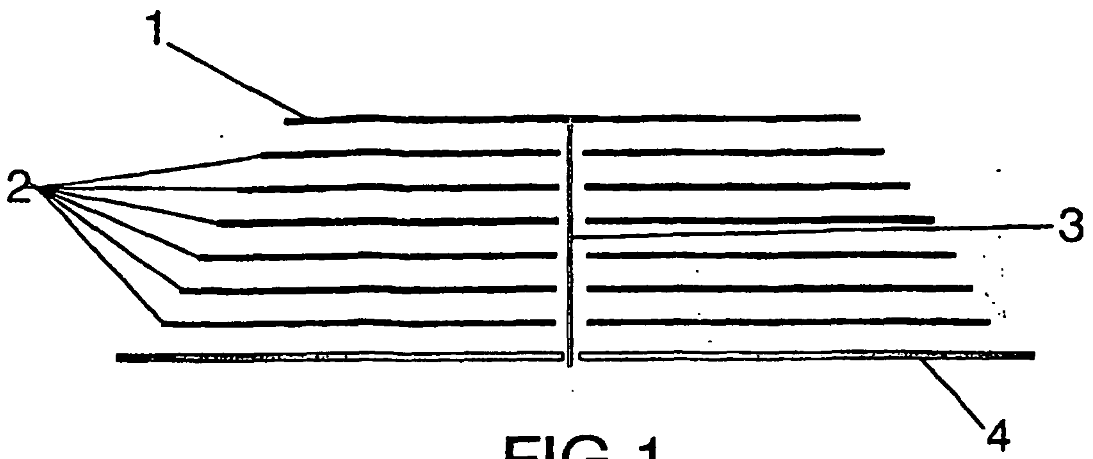

FIG.1

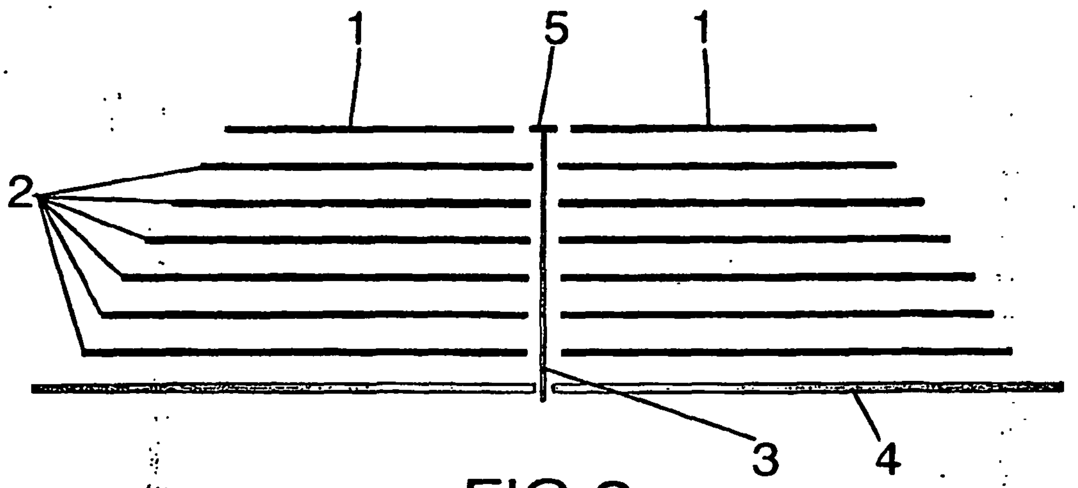

FIG.2

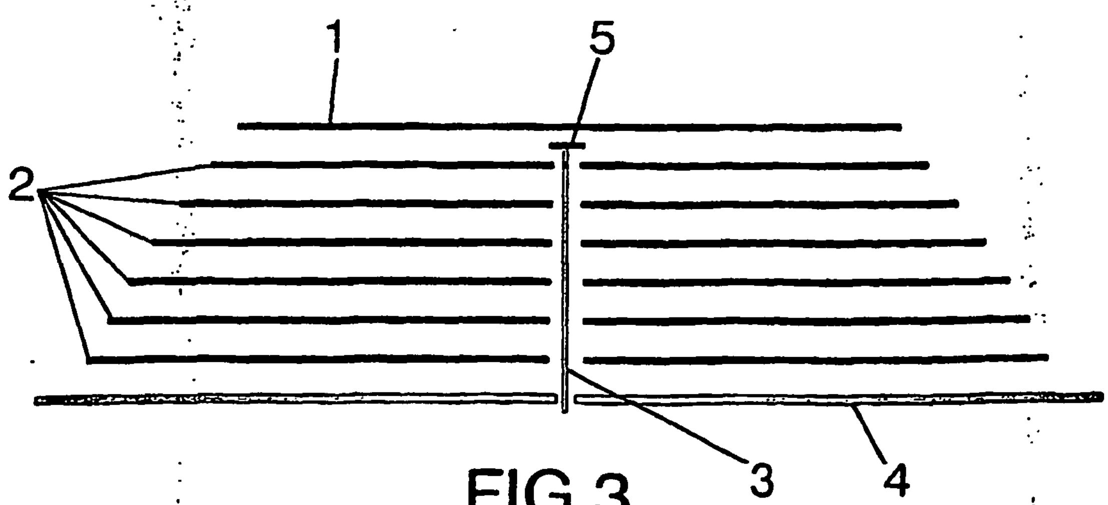

FIG.3

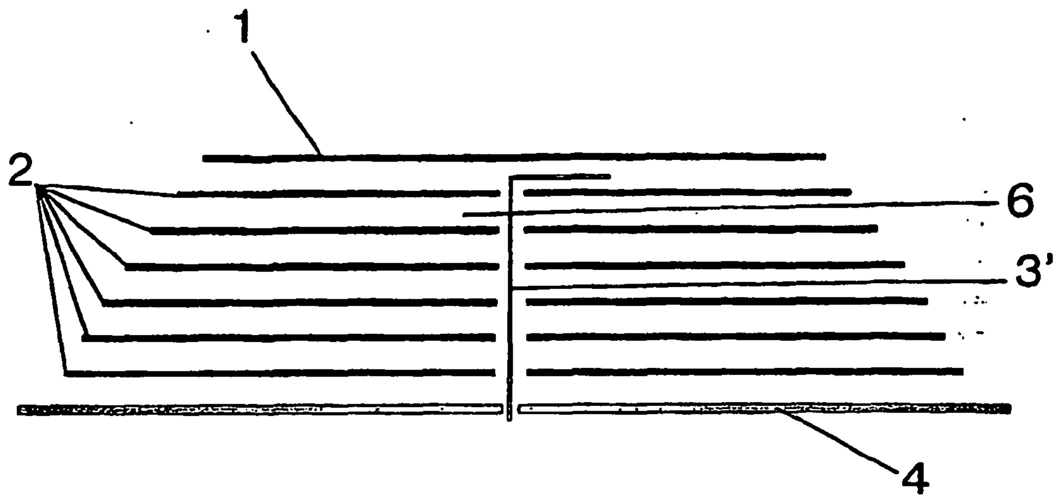

FIG.4

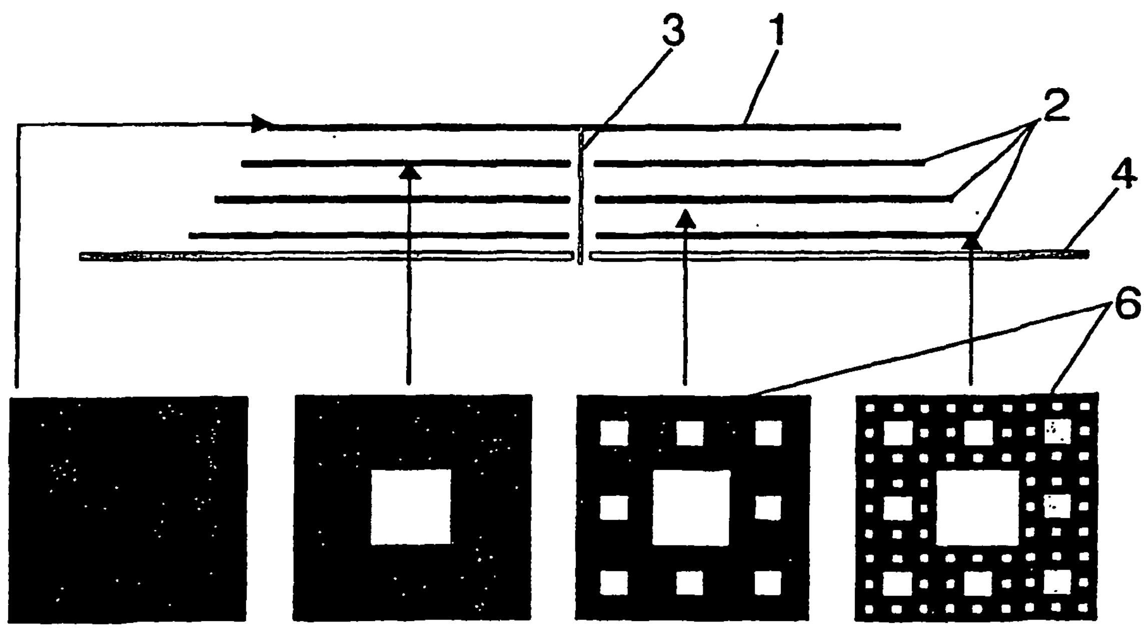

FIG.5

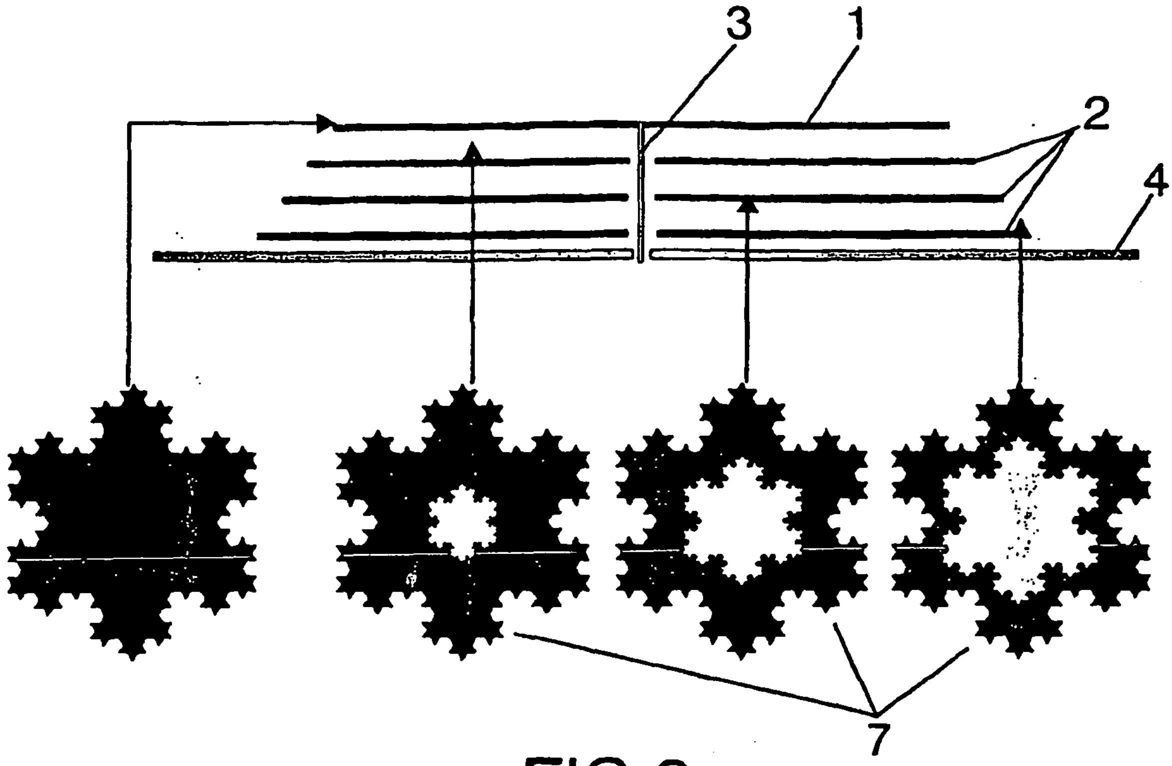

FIG.6

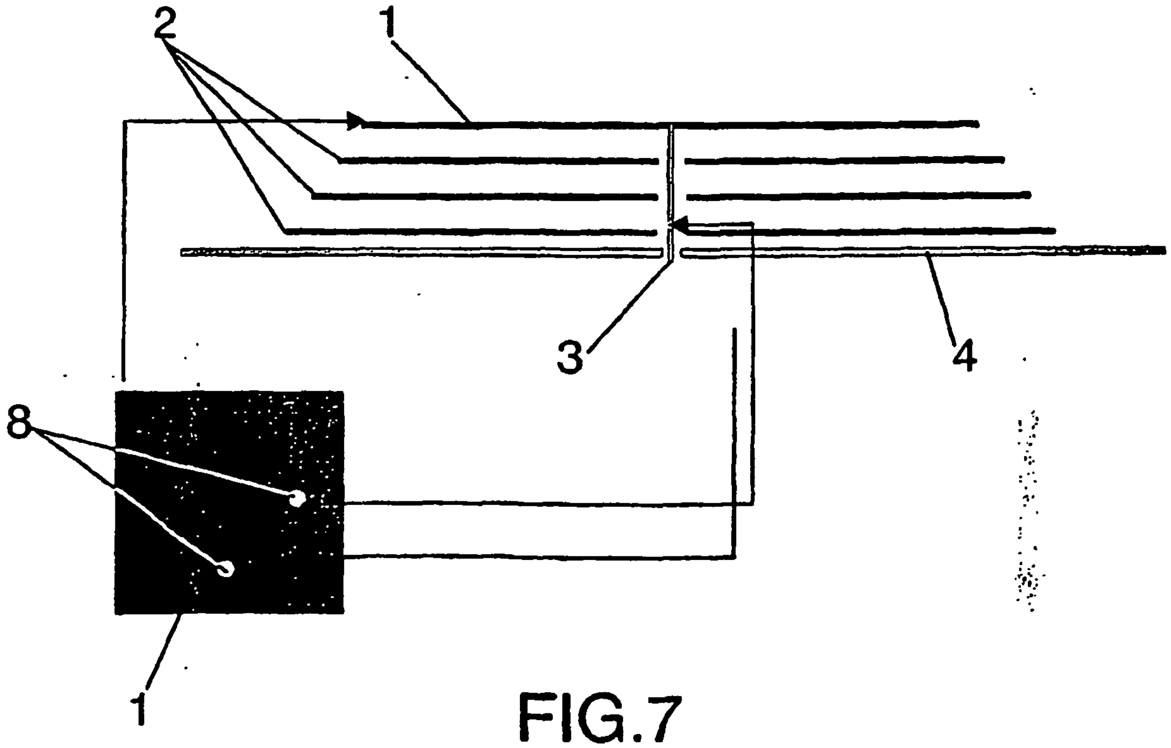

FIG.7

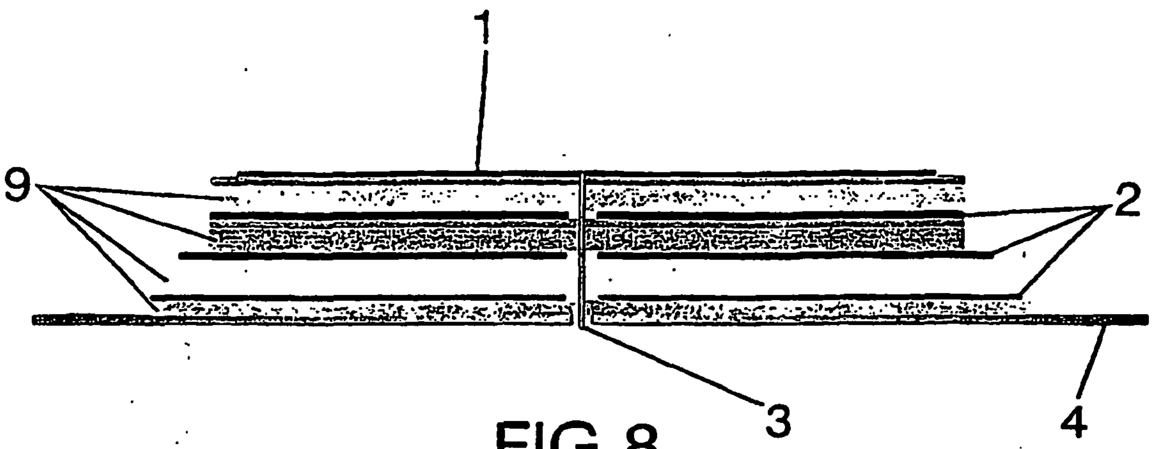

FIG.8

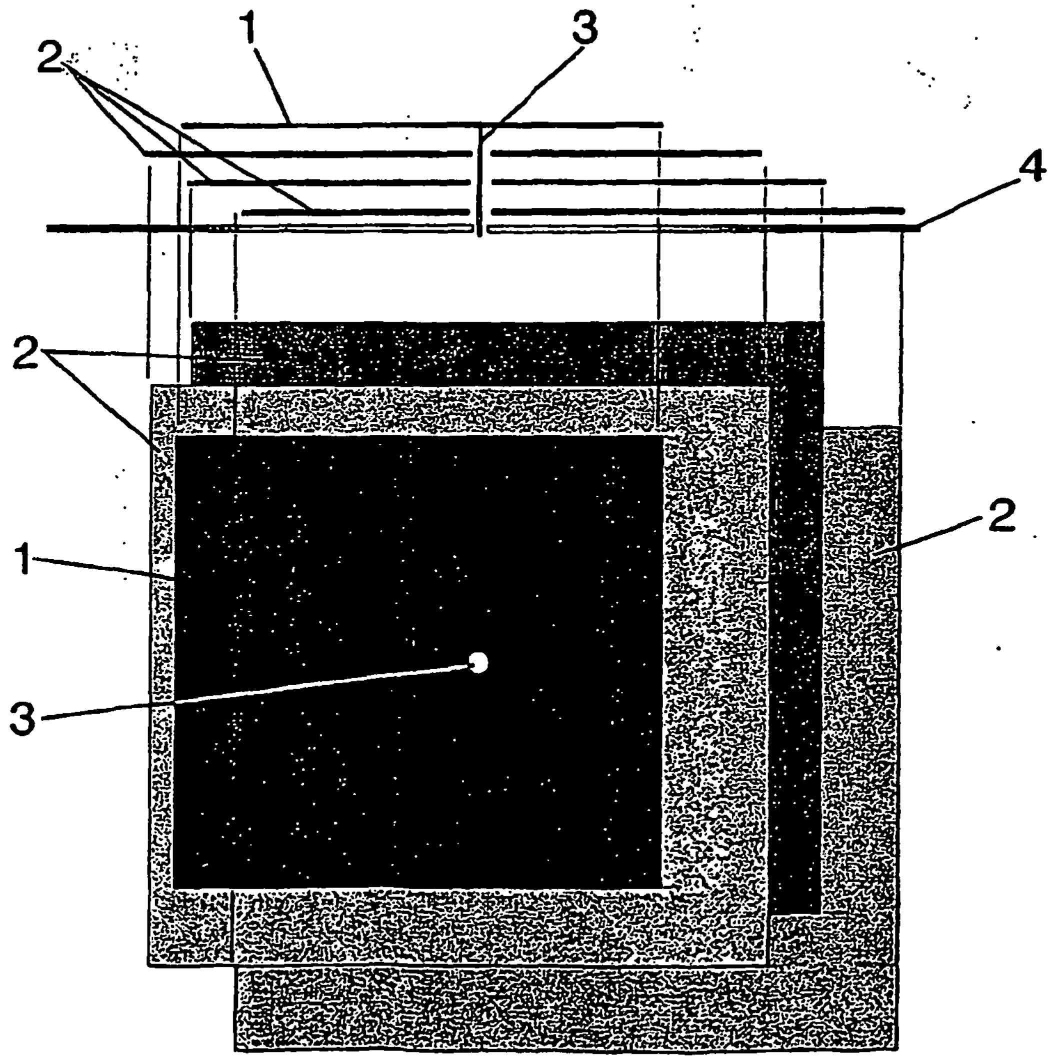

FIG.9

REFERENCES CITED IN THE DESCRIPTION

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