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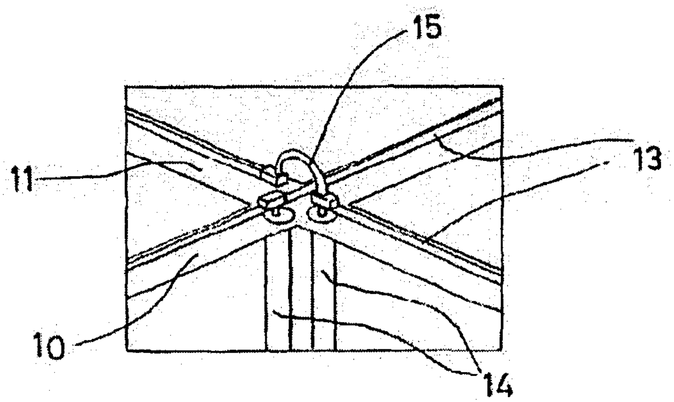
(54) Dual-polarization antenna's radiating element

(57) The invention pertains to a double polarization antenna's radiating element comprising a pair of half-wave dipoles (3, 4; 5, 6) for each polarization. The dipoles (3, 4; 5, 6) are disposed upon a first phase of a dielectric medium (12). Each dipole (3, 4; 5, 6) forms a conducting rectangular plane whose ends (7) are folded onto the central section (8), and a junction (10, 11) in the form of a conducting strip ensuring the connection between the two dipoles of the same polarization. Each pair of dipoles (3, 4) and (5, 6) is respectively supplied by a microband conducting line (13) disposed onto a second face opposite the dielectric medium (12). The conducting lines (13) respectively supplying each of the pairs of dipoles (3, 4) and (5, 6), are placed within the same plane, and a jumper cable (15) ensures that one line (13) overlaps the other at the crossing point.

The junction (10, 11) is connected to the dipole at a point where the current is at a maximum and voltage is at a minimum, which enables each polarization's pair of dipoles (3, 4; 5, 6) to be supplied by a single coaxial cable (14) via a supply line (13).

FIG_2



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Description

[0001] The present invention pertains to a dual-polarization antenna's radiating element.

[0002] So-called "butterfly" radiating elements which are made up of multiple assembled parts, as described in the document EP-0 895 303. The radiating element comprises two orthogonal dipoles each comprising two conducting elements; each conducting element is folded into a V to form two wings, mounted on a reflector or ground plane. However, this configuration has a directivity limitation. As the surface currents traveling through the wings are limited, it is at best equivalent to two half-wave dipoles arranged orthogonally.

[0003] So-called "TV" radiating elements are also known, used in television transmission antennas. Their cast structure is fairly difficult to construct. Additionally, this structure requires that the radiating element is supplied by four coaxial cables,

[0004] So-called "patch" radiating elements are also known, printed on a printed circuit board (PCB), for which multilayer techniques should be used in order to achieve the desired characteristics. These radiating elements are generally made up of a square conducting surface which is approximately a half-wavelength on each side. However, the currents, which are neither concentrated nor guided, are distributed across the entire square surface, which results in lower polarization purity. Furthermore, the usable frequency band is narrow, about ± 5% around the central frequency.

[0005] The purpose of the present invention is to implement a dual-polarization antenna's radiating element having a very large current surface area, and consequently a maximized directivity.

[0006] Another purpose of the invention is to propose a dual-polarization antenna's radiating element whose radio-etectric characteristics are stable over a very large frequency band.

[0007] Another purpose of the invention is to propose a dual-polarization antenna's radiating element whose volume and cost are minimized:

[0008] The object of the present invention is a dual-polarization antenna's radiating element comprising a pair of half-wave dipoles for each polarization, each dipole forming a conductive rectangular plane whose ends are folded onto the central section, and a junction formed of a conducting strip ensuring the connection between the two dipoles with the same polarization. According to the invention, the dipoles are arranged on a first face of a dielectric medium, each dipole pair being respectively supplied by a microband conducting line arranged on the second face opposite the dielectric medium. Also according to the invention, the conducting lines respectively supplying each of the dipole pairs are placed within the same plane, and a jumper cable ensures that one line overlaps the other at the crossing point.

[0009] According to one preferred embodiment, the junction is connected to the dipole at a point where the current is at a maximum and voltage is at a minimum, which makes it possible not to change the distribution of currents within the radiating element.

[0010] According to another embodiment, each polarization's pair of dipoles is supplied by a single coaxial cable. The coaxial cable is connected to a supply line, for example a microstrip, which supplies each pair of dipoles.

[0011] According to another embodiment, a single pair's dipoles are separated from one another by a distance of a half-wavelength.

[0012] According to a first embodiment, the dipoles are printed onto the lower surface of the dielectric medium, and the conducting lines are printed onto the upper surface of the dielectric medium.

[0013] According to a second embodiment, at least one of the components of the radiating element chosen from among the dipoles, injunctions, and the supply lines is cut from a thin metal plate.

[0014] According to one variant, a pair of dipoles and the corresponding junction is cut from a single piece within a thin metal plate.

[0015] The invention discloses a radiating element which is equivalent to two half-wave dipoles for each polarization, owing to surface currents traveling over a larger surface area than in a "butterfly" radiating element of the prior art. As this radiating element's directivity is greater than for the radiating elements of the prior art, only a reflecting plane with lower dimensions is needed to lead to an equivalent beamwidth. As the radiating element is more directive, the backfire value is lower. Consequently, the double-polarization antennas resulting from the joining of these radiating elements is smaller and thicker than the antennas of the prior art.

[0016] The inventive radiating element is mechanically very simple, and includes fewer parts than the radiating elements of the prior art. In particular, it includes only two coaxial cables, a ground plane or reflector with reduced surface area, and potentially an insulating plane substrate, for example such as the one used for a printed circuit board, compared with the many parts used for constructing the radiating elements of the prior art. The construction of the inventive radiating element does not require any welding, and minimizes the materials used.

[0017] From an impedance standpoint, the radiating element is large-band, owing to the coupling of the half-wave dipoles, which makes it possible to reduce the distance between the dipoles and the reflector, and therefore to achieve a less thick antenna. It is no longer necessary to add a balun.

[0018] The inventive radiating element may be used in large-band antennas, typically including multiple bands, for example DCS, PCS, and UMTS. It is possible to adapt the impedance to a large frequency band by using the significant surface area available for the microstrip line.

[0019] A further object of the invention is a double-polarization antenna comprising radiating elements as described above.

[0020] Other characteristics and advantages of the invention will become apparent while reading the following description of embodiments, which are non-limiting and given for purely illustrative purposes, and in the attached drawing, in which:

- Figure 1 depicts a perspective view of a radiating element according to one embodiment of the invention,
- Figure 2 shows in detail the pairs of dipoles of the radiating element of Figure 1,
- Figure 3 depicts a top view of another embodiment of a radiating element,
- Figure 4 is the co-polarization and cross-polarization radiation pattern of the radiating element of Figure 1. The intensity of the radiation R in dB is given as the y-axis, and the radiation angle φ in degrees is the x-axis.
- Figure 5 depicts the reflection coefficient of each of the pairs of dipoles of Figure 1 both during co-polarization and cross-polarization, and the insulation between the two pairs of dipoles. The reflection coefficient and the insulation I in dB is given as the y-axis, and the frequency F in GHz as the x-axis.

[0021] In the embodiment of the invention depicted in Figures 1 and 2, a radiating element **1** is mounted onto a metal plate serving as a reflector **2** placed a short distance away, about one quarter-wavelength of the radiating element **1.** The reflector's **2** edges are folded or shaped so as to enable adjustment of the radiation pattern.

[0022] The double-polarization radiating element **1** comprises, for the first polarization, a first dipole **3** and a second dipole **4,** and for the second polarization, a third dipole **5** and a fourth dipole **6.** The dipoles **3, 4, 5, 6** are rectangular planes forming "C" shapes, the two ends **7** being folded onto the central section **8** so as to create a T-shaped slope **9** between these sections. Between the two dipoles **3, 4** and **5, 6** of the same polarization, positive or negative, a junction **10, 11** in the form of a strip joins the two dipoles **3, 4** and **5, 6** of the same pair. The jonction **10, 11** is connected to the dipoles **3, 4, 5, 6** at points where the current is at a maximum and voltage is at a minimum, which makes it possible to not change the distribution of currents within the radiating element. The dipoles of each pair **3, 4** and **5, 6** are separated from one another by a distance of a half-wavelength.

[0023] The dipoles **3, 4, 5, 6** as well as their respective junctions **10, 11** are printed onto the lower face of the dielectric medium **12** of a printed circuit. The upper face of the dielectric medium **12** supports the microstrip supply lines **13** of each of the dipoles. The junctions **10, 11** of the dipoles **3, 4, 5, 6** are used as a ground plane for the microstrip line **13.** As shown in detail in Figure 3, the pair of two dipoles **3, 4** and **5, 6** for each polarization is directly supplied near the center of the radiating element **1** by a single coaxial cable **14,** each cable **14** supplying the microstrip lines **13** associated with one of the junctions **10** or **11.**

[0024] As the microstrip lines **13** are coplanar, a jumper cable **15** ensures that the microstrip lines **13** overlap one another at their crossing point. Having coplanar microstrip lines **13** affords many advantages when constructing radiating elements **1,** particularly in terms of form factor, complexity of assembly, and cost. The problem of minimizing the volume and cost of the radiating element **1** in comparison to existing elements has thereby been solved. This is because when the supply lines are arranged on either side of the dielectric medium, this requires using two dielectric medium thicknesses separated by a ground plane. Additionally, the grounding of the dipoles, via the braid surrounding the coaxial cable, becomes very complicated. In this situation, it is understood that, particularly owing to its more complicated construction and the increase in the quantity of materials needed, the final product is much more expensive than the radiating element **1** of the invention.

[0025] Dipoles **3, 4, 5, 6** may be constructed by etching a copper substrate of the type used to create printed circuit boards. A conductive paint can also be used, or the technique of screenprinting.

[0026] This concept enables the proximity between the radiating element **1** and the reflector **2** leading to a total antenna thickness which may be less than 80 mm. and preferentially about 60 mm for the GSM 900 and, as opposed to 85 mm at present. The radiating element **1** enables satisfactory uncoupling (approximately 30 dB of insulation) between the two layers of dipoles **3, 4** and **5, 6.**

[0027] According to another embodiment depicted in Figure 3, the pair of dipoles **30, 31** and their junction **32** are directly tied into a thin conductive plate, for example from a single part. A substrate with a large surface area is no longer necessary, and the supply lines **33** may be placed directly onto the cut plate, with a localized insulating substrate being placed in between. The supply lines **33** may also be cut from a thin conductive plate. In this situation, the jumper cable may be created directly by folding the cut plate.

[0028] Figure 4, which depicts the radiation pattern of the radiating element, will now be considered. The bell-shaped group of curves **40** corresponds to the co-polarization components, and the V-shaped group of curves **41** corresponds to the cross-section polymerization component, respectively for frequencies of 800 MHz, 900 MHz, 1 GHz, and 1.1 GHz. The cross-section polymerization depicted by the V-shaped curves **41** must be minimized. The usable frequency band is about ± 21% around the central frequency. At a radiation level R = -3dB, the beamwidth Δφ **42** is about 60° to 65°, and the variation in the opening **43** (gap between the curves) remains very low within the frequency band studied (800 MHz to 1.1 GHz). The distinction between the two polarizations, shown as the distance between the group of co-polarization curves **40** and the group of cross-polarization curves **41** is better than 32dB within the azimuth axis φ = 0°.

[0029] Figure 5 depicts the reflection coefficient C for the two pairs of dipoles and the insulation I between these pairs. The reflection coefficient **50, 51** remains greater than 15dB for each of the two pairs of dipoles over a frequency band of 850 MHz to 1180 MHz. The usable frequency band is about ± 16.5% around the central frequency, as opposed to about ± 10% around the central frequency for a "patch" radiating element of the prior art. The insulation **52** between the two pairs of dipoles remains better than 26dB over an extremely broad frequency band.

[0030] These Figures 4 and 5 show that the radio-electric characteristics of the radiating element, according to the embodiment of the invention just described, are advantageously stable over a very broad frequency band.

Claims

1. A dual-polarization antenna's radiating element comprising a pair of half-wave dipoles (3, 4) and (5, 6) for each polarization, each dipole forming a conductive rectangular plate whose ends (7) are folded onto the central section (8), and a junction (10, 11) in the form of a conducting strip ensuring the link between these two dipoles (3, 4; 5, 6) with the same polarization, **characterized in that** the dipoles (3, 4; 5, 6) are disposed upon a first surface of a dielectric medium (12), each pair of dipoles a (3, 4) and (5, 6) being respectively supplied by a microband conducting line (13) disposed upon a second surface opposite the dielectric medium, and that the connecting lines (13) respectively supplying each of the pairs of dipoles are placed within the same plane, a jumper cable (15) ensures that one line overlaps the other at the crossing point.

2. A radiating element according to claim 1, wherein the junction (10, 11) is connected to the dipole (3, 4, 5, 6) at a point where the current is at a maximum and the voltage is at a minimum.

3. A radiating element according to one of the claims 1 and 2, wherein the pair of dipoles (3, 4; 5, 6) of each polarization is supplied by a single coaxial cable (14).

4. A radiating element according to one of the claims 1 to 3, wherein the dipoles (3, 4; 5, 6) of a single pair are separated from one another by a distance of a half-wavelength.

5. A radiating element according to one of the claims 1 to 4, wherein the dipoles (3, 4; 5, 6) are printed onto the lower face of the dielectric medium (12), and the conducting lines (13) are printed onto the upper face of the dielectric medium (12).

6. A radiating element according to one of the claims 1 to 4, wherein at least one of the radiating element's components chosen from among the dipoles (30, 31), the junctions (32), and the supply lines (33) is cut from a thin metal plate.

7. A radiating element according to claim 6, wherein one pair of dipoles (30, 31) and the corresponding junction (32) are cut from a single piece within a thin metal plate.

8. A double-polarization antenna comprising radiating elements according to one of the preceding claims.

FIG_1

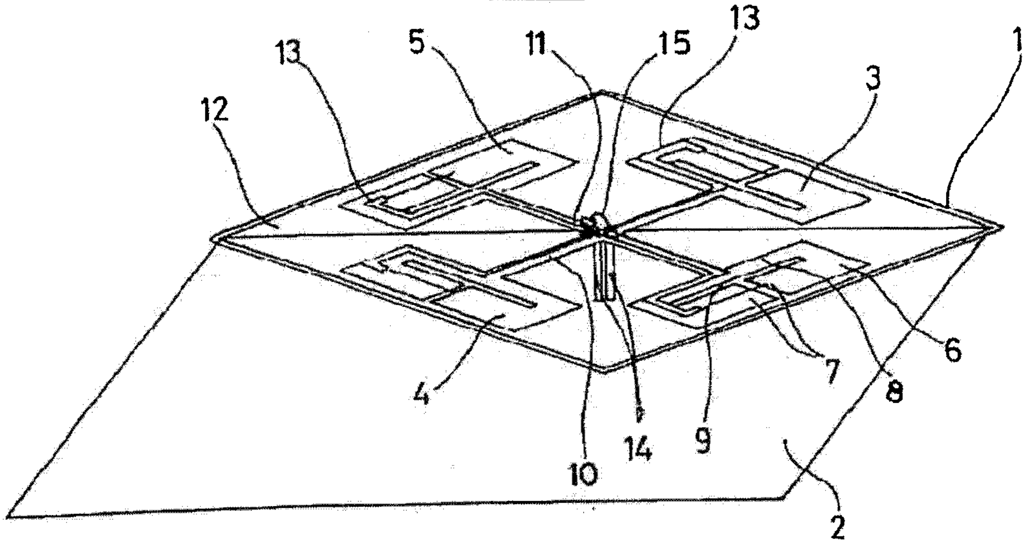

FIG_2

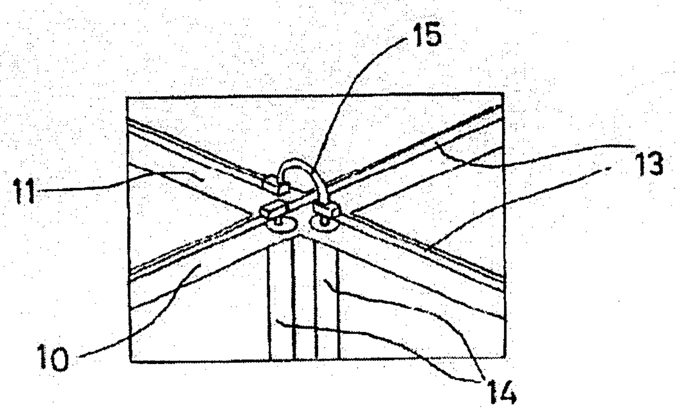

FIG_3

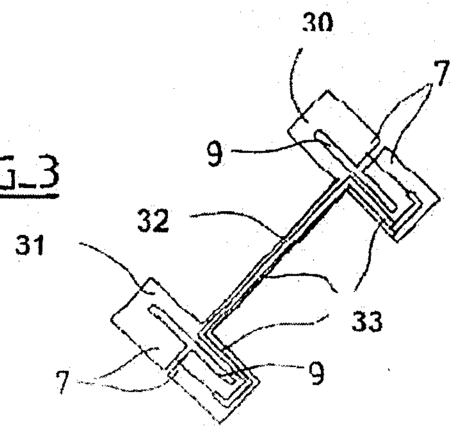

FIG_4

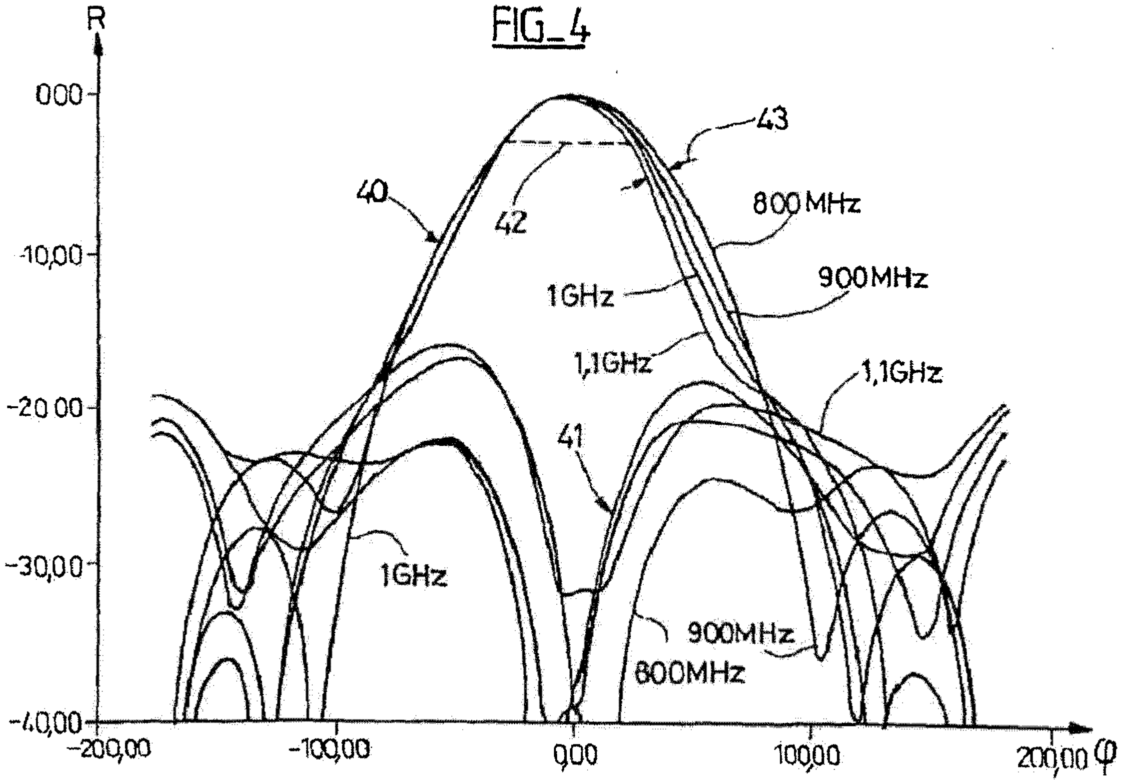
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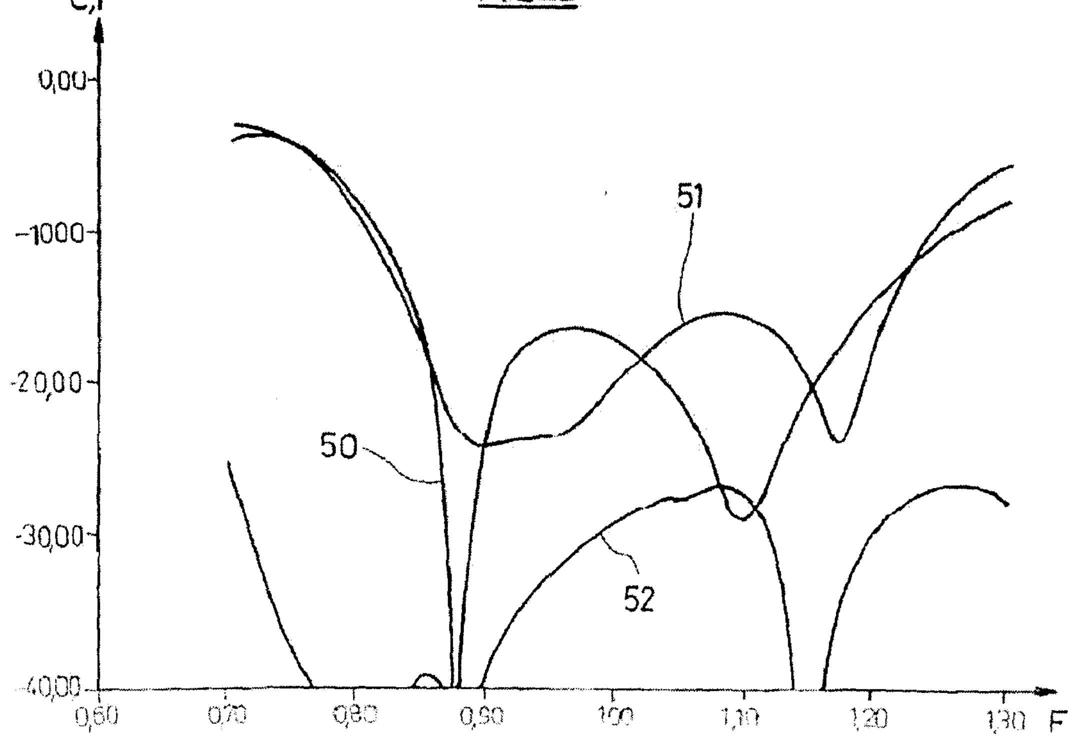
FIG_5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EUROPEAN SEARCH REPORT

Application Number
EP 10 18 2687

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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

1

Place of search	Date of completion of the search	Examiner
Munich	16 December 2010	Ribbe, Jonas

CATEGORY OF CITED DOCUMENTS

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