

DUAL POLARIZED RADIATOR FOR LENS ANTENNAS

FIELD OF THE INVENTION

The present invention relates to antennas emitting or receiving two orthogonal polarizations such as vertical and horizontal or ± 45 degree slants. More particularly, the present invention relates to lens antennas creating a set of beams having frequency independent constant beamwidth.

DESCRIPTION OF RELATED ART

It is known from the prior art that beamwidth of a beam radiated by lens antennas operating over a wide band of frequencies varies inversely with frequency.

While a variation in beamwidth due to a change in operating frequency maybe tolerated in many applications. Cases exist where such a variation seriously affects proper performance.

For example, if (when the lens antenna is to produce a plurality of simultaneously existing beams) it is desired to maintain the power level at crossover points between adjacent beams, any variation in beamwidth due to a change in operating frequency obviously should be avoided. Similarly, if (when the lens antenna is to produce a single beam) it is desired to reduce clutter when a beam is pointed so as to graze an extended area, as the sea or a land mass, it is also obvious that any variation in beamwidth due to a change in operating frequency should be avoided.

Several methods of decreasing variation of beamwidth versus frequency are known from the prior art. Many years ago Gillard and Franks [C. Gillard and R. Franks, "Frequency independent antenna – several new and undeveloped ideas," Microwave J., pp. 67-72, February 1961] showed that if a lens or reflector were illuminated by a feed whose beamwidth varied inversely with frequency, then secondary pattern beamwidth should remain essentially constant. This effect does not occur unless the primary feed beamwidth is sufficiently narrow so that the entire beam of the feed is on the reflector or lens. By mentioned above method constant beamwidth antenna was developed [Kenneth L. Walton and Vernon C. Sundberg, "Constant beamwidth antenna development," IEEE Trans. On Antennas and Propagation, Vol. AP-16, No. 5, September 1968] using the pyramidal horn for illumination a parabolic reflector. A lens was used in the aperture of the horn to correct phase errors. The developed antenna contains a big reflector dish and provides Gain more than 20 dB therefore a pyramidal horn efficiently illuminates a big reflector dish. Due to a pyramidal horn has big dimensions one don't suit for relatively small antennas having Gain less than 20 dB and multi beam lens antennas having many feeds placed close to each other.

US2013/0069832 A1 describes the method of shifting a phase centre of a feed signal farther from a reflector dish of the reflector antenna while increasing a frequency of operation of the reflector antenna by an offset corrugated feed horn. Corrugation of the horn is offset from the face of the horn. In this manner, the phase centre of the signal from the feed horn moves away from the reflector dish as frequency increases. In this manner, the beam from the reflector dish is "de-focused" or broadened as frequency increases, in contrast to conventional corrugated horn which the phase centre remains at physical centre of the horn aperture for all frequencies.

The offset corrugated horn creates a wide beam therefore a reflector dish has to have focal ratio F/D at least less than 0.3 to effectively reflect the signal from the horn. Spherical lenses usually have a focal ratio F/D more than 0.5 therefore ones can't be properly illuminated by an offset corrugated horn.

[Ming Huang; Shiwen Yang; Wei Xiong; Zhijia Liu; Zaiping Nie, "Optimal design of a spherical lens antenna with practical feed model," *Antennas and Propagation (APSURSI), 2011 IEEE International Symposium on*, vol., no., pp.926,929, 3-8 July 2011] describes the spherical lens antenna containing corrugated and dielectric loaded horns. Dielectric loaded horns are smaller than usual horns operating at the same frequency therefore it is possible to use ones for lens antennas creating many beams but horns have big length therefore such antennas have big dimensions.

Log-period dipole antennas were also used as "de-focused" feeds of dish reflectors. For example, [Aumann, H.M.; Emanetoglu, N.W., "A constant beamwidth reflector antenna for a harmonic radar operating in the near-field," *Antenna Technology and Applied Electromagnetics (ANTEM), 2014 16th International Symposium on*, vol., no., pp.1,2, 13-16 July 2014] describes a dual band antenna providing the same beamwidth at 5.8 GHz and 11.6 GHz. The reflector dish of this antenna has $F/D=0.45$ but the log-period dipole antenna having a wide beam is placed between focus and the reflector dish to provide efficient illumination of the reflector dish. Due to log-period dipole antennas create wide beams ones can't efficiently illuminate spherical lenses.

US6169525 B1 describes multi beam antenna system containing a lens fed by low profile broadband feed devices, such as log-period dipole arrays and tapered notch antennas. Both these antennas has a low F/B ratio and don't provide enough isolation between neighbour

feeds of multi beam antenna. Due to these disadvantages ones can't be used in multi beam antennas for modern wireless communication.

5 WO92/3373 describes antenna system containing a lens and helical feeders integrated in this lens. This method improves illumination of hemispherical lens by feeders creating wide beam but it is difficult to manufacture such lenses. Moreover it is impossible to move integrated feeders and scan beams.

10 US2008/0278394 A1 describes the lens antenna fed by patches providing as linear so as circular polarization. Such feeder has small dimensions but position of its phase center and beamwidth have small dependence versus frequency therefore one can't provide constant beamwidth of a lens antenna.

15 US4042935 describes the feed antenna containing a plurality of nested annular cavities each parasitically exited by a pair of orthogonal two point fed dipoles. This feed antenna together with 180 degree hybrid networks and a multiplexing device can operate in a wide frequency band but it is very difficult to manufacture the entire assembling.

20 US5940044 describes a dual slant polarized antenna having approximately 65 degrees half power beam width in the horizontal plane. This antenna includes a plurality of dipole sub-arrays with each sub-array comprising four dipoles arranged in a diamond shape. Two dipoles of each sub-array are tilted at an angle of +45 degrees from the long edge of the ground plate to form a +45 degree polarized radiating element array. The other two dipoles are arranged at an angle -45 degrees from the long edge of the ground plate to form a -45
25 degree polarized radiating element array. The dipoles are arranged such that the phase centers of one +45 degree dipole and one -45 degree element line up along a first vertical line which is parallel to the long edge of a ground plate. The phase centers of the other + 45 degree dipole and -45 degree element line up along a second vertical line. The main disadvantage of this dipole square is the complicated feed network. For example, four cables
30 have to be used for feeding the dipoles.

EP0973231A2, US6333720B1, US6529172B2 and US2010/0309084A1 describe radiators having a dipole square shape. Baluns of the same dipoles are tilted to the center of the dipole square to simplify manufacturing. In spite of this new shape, these devices are still
35 complicated.

US6313809B1 describes a dual polarized radiator comprising four dipoles preferably arranged above a reflector and forming a dipole square structurally in the top view. Each dipole is fed by means of a symmetrical line characterized by the following features. The radiator radiates electrically in polarizations at an angle of +45 or -45 degrees to the structurally prescribed alignment of dipoles. The ends of symmetrical lines leading to the respective dipole halves are connected in such a way that the corresponding line halves of the adjacent, mutually perpendicular dipole halves are always electrically connected. The electric feeding of the respectively diametrically opposite dipole halves is performed in a decoupled fashion for a first polarization and a second polarization orthogonal thereto.

Other modifications of the dipole square are described in US6940465B2, US7688271B2, CN202423543U, CN202268481U, CN101916910A, CN102097677A, CN102694237A, CN102544711A, CN201199545Y, CN102117967A and CN102013560A.

WO2007/114620A1 describes a dual polarized radiator comprising four folded dipoles preferably arranged in the same way as dipoles of the radiator described in US6313809B1. Other modifications of a dipole square formed by four folded dipoles are described in CN101707292A, CN201430215Y, CN202178382U, and CN202004160U. Folded dipoles coupled with a dipole square by capacitive coupling are described in CN102377007A, CN201117803Y, CN201117803Y and CN101505007A.

Many other dual polarized radiators having smaller dimensions were invented. Crossed dipoles having different kinds of dipole arms are described in US6933906B2, US7132995B2, US2012/0235873 A1, CN102074779A, CN102157783A, CN101707291A, CN101572346A, CN201741796U, CN101546863A, CN101673881A, CN202150554U, CN102246352A, CN102484321A, CN202423541U, CN102544764A and CN101707287A. At the H plane, a beam of crossed dipoles is too wide. Therefore, big side walls are used to reduce a beam width as shown, for example, in US7679576B2.

Crossed dipoles containing different coupling elements between dipoles arms are described in CN201060942Y, CN201011672Y, CN202076403U, CN201243085Y and CN201898199U. These coupling elements create additional oscillating contours which increase operating frequency band of crossed dipoles. Such radiators are described in WO 2010/079797 and US2011/0291905 A1, and one such radiator is shown in Fig. 1 as the prior art. The known radiator 53 comprises two crossed dipoles containing four arms 54 and a connective portion 52 of a square shape connecting far corners of arms 54 with each other. Each arm 54 has a shape of a square frame and together with the connective portion 52, forms four oscillator

arms 531-534 which form a radiating structure of a square shape (seen from a top view). Feeding terminals 5310-5340 are placed at corners facing another oscillator arm. In another variant of the known radiator, the connective portion has four parts of a shape of folded dipoles connected with two adjacent sides of two adjacent oscillator arms, respectively.

- 5 Folded dipoles formed by a connective portion and connected to oscillator arms act as a dipole square, as described in WO 2007/114620A1.

10 The mentioned above dipole squares and crossed dipoles developed for base station antennas provide good F/B ratio and 65 degree beamwidth but its beamwidth and position of a phase center have very low dependence versus frequency.

15 Thus some of known feeds for dish and lens antennas are too big and complicated for manufacturing. Other known radiators having simple structures haven't suitable beamwidth dependence versus frequency to be used as feeds of lens antennas providing constant beamwidth.

BRIEF DESCRIPTION OF PREFERRED EMBODIMENTS

20 Embodiments of the invention seek to overcome the above described problems of prior techniques by providing a relatively small dual polarized radiator creating beamwidth about 65 degree at a low frequency of operating frequency band and varying inversely with frequency or at least having a minimal deviation from this dependence over a wide frequency band.

25 Embodiments of the invention also seek to provide a relatively small dual polarized radiator for lens antennas creating beams which can remain almost constant in a beamwidth over a wide frequency band.

30 Embodiments of the invention also seek to provide a relatively small dual polarized radiator providing high isolation between feeds of a multi beam lens antenna.

Embodiments of the present invention further seek to create a dual polarized feed for lens antennas which may be easy to be manufactured.

35 According to an embodiment of the invention, there is provided a dual polarized radiator comprising: a radiating arrangement; and a feeding element containing two feeding lines and forming two perpendicular baluns supporting the radiating arrangement above a reflective conductive

plate having side walls, a dielectric body and four directing conductive strips. The radiating arrangement comprises two crossed dipoles connected by four outer conductors. The four outer conductors form an outer contour of the radiating arrangement having a shape of a circle or a polygon. Each crossed dipole contains two dipole arms comprising two equal branches connected together at a point of connection between the dipole arm and one of the two feeding lines. A first gap between the two equal branches of each dipole arm and a second gap between adjacent branches of different dipole arms increase towards the outer contour of the radiating arrangement. Each outer conductor has a middle portion and two end portions. The middle portion connects adjacent branches of the different dipole arms with the two end portions, wherein one end portion is placed between the branches of one dipole arm and the other end portion is placed between the branches of an adjacent dipole arm. One end portion of one outer conductor and the other end portion of an adjacent outer conductor are placed between the two branches of one of the dipole arms and are separated from each other by a third gap creating a capacitive coupling between the two outer conductors. The dielectric body is placed above the radiating arrangement.

The four directing conductive strips are placed above the reflective conductive plate and below the radiating arrangement. Each directing conductive strip is placed in parallel to the middle portion of one of outer conductors between the said middle portion and a side wall of the reflective conductive plate. The said radiator forms a beam having beamwidth varying inversely with frequency or at least having a minimal deviation from this dependence.

The radiating arrangement may be formed from a single sheet of conductive material.

The radiating arrangement and the feeding element may be made as one part by die-casting.

The feeding element may be connected to the dipole arms in the middle of the radiating arrangement and may comprise four tubes containing two coaxial cables inside and connected by a flat conductor nearby the reflective conductive plate.

The inner conductors of the coaxial cables are connected to the radiating arrangement by conductive bridges.

The dual polarized radiator may further comprise a thin dielectric film placed between the feeding element and a conductive plate.

A distance between the radiating arrangement and the conductive plate may be smaller than 0.25 wave length corresponding to a middle operating frequency.

BRIEF DESCRIPTION OF THE DRAWINGS

5 The accompanying drawings, which are incorporated in and constitute part of the specification, illustrate embodiments of the invention and, together with the general description of the invention given below, serve to explain the principles of the invention.

In the accompanying drawings:

10 Fig. 1 is a dual polarized radiating element from the prior art (WO 2010/078797, US2011/0291905A1), wherein four square arms are connected by connective portions to form four oscillator arms, which form a radiating structure of a square shape in a top view.

15 Fig. 2a is a perspective view of the dual polarized radiator according to an embodiment of the present invention.

Fig. 2b is a perspective view of the dual polarized radiator where a dielectric body is removed to show parts placed below a dielectric body in Fig. 2a.

20 Fig. 3 is a top view of the radiating arrangement shown in Fig. 2b.

Fig. 4 is the cross section through the center and the tube containing feeding coaxial cable of the other embodiment of the dual polarized radiator containing an additional conductive plate separated from a conductive plate by a dielectric film.

25

Fig. 5a illustrates co polar radiation patterns of the dual polarized radiator shown in Fig. 2a.

Fig. 5b illustrates cross polar radiation patterns of the dual polarized radiator shown in Fig. 2a.

30

Fig. 6 is a schematic top view of a multi beam lens antenna containing 12 dual polarized radiators shown in Fig. 2a.

Fig. 7a illustrates co polar radiation patterns of a beam of a multi beam antenna shown in

35 Fig. 6 with dual polarized radiators according to the present invention.

Fig. 7b illustrates cross polar radiation patterns of a beam of a multi beam antenna shown in Fig. 6 with dual polarized radiators according to the present invention.

DETAILED DESCRIPTION

5

Fig. 2a shows a perspective view of the dual polarized radiator according to an embodiment of the present invention comprising a dielectric body 100 supported above a radiating arrangement 101 by dielectric spacers 102 fixed on conductive plate 103 containing side walls 104. In Fig. 2b a dielectric body 100 is removed to show other parts of the dual
 10 polarized radiator. The radiating arrangement 101 made of a thick conductive material in a shape of planar structure supported above a conductive plate 103 by a feeding element containing four conductors 67-70 forming two perpendicular baluns. A conductor 67 and 68 forms the first balun. A conductor 69 and 70 forms the second balun. The top ends of conductors 67-70 are connected to feeding points of a radiating arrangement 101 and the
 15 bottom ends are connected to a conductive plate 103. Conductors 67 and 69 are made in a shape of tubes which are outer conductors of feeding coaxial cables in the same time. Inner conductor 91 and 92 of the feeding coaxial cables are placed inside of tube 67 and 69 and connected to conductive bridges 93 and 94 respectively. Other ends of these bridges are connected to conductors 68 and 70 respectively.

20

The dual polarized antenna radiates two mutually perpendicular electrical fields having E vectors directed along conductive bridges 93 and 94 as shown in Fig. 2b.

A top view of a radiating arrangement 101 comprising two crossed dipoles is shown in Fig. 3.
 25 Each dipole comprises two dipole arms, wherein each dipole arm has two equal branches connected at feeding points 17-20. Feeding points 17-20 are disposed in the middle of the radiating arrangement.

Four outer conductors 9-12 form the outer contour (or boundary or perimeter) of the radiating
 30 arrangement, and connect adjacent branches of dipole arms of crossed dipoles. Each of these conductors 9-12 has two end portions and a middle portion, the middle portion connecting adjacent branches and two end portions. The first end portion is placed between branches of a vertical dipole's arm and the second end portion is placed between branches of a horizontal dipole's arm.

35

The distance between branches of a dipole arm increases towards the outer contour of the radiating arrangement. The distance between adjacent branches of crossed dipoles also

increases towards the outer contour of the radiating arrangement. Adjacent end portions of conductors 9-12 placed between branches of a one arm are separated by gaps creating a capacitive coupling between these conductors. The outer contour of the radiating arrangement formed by conductors 9-12 is made in a shape of a circle (or substantially circular, e.g. having discontinuities in the circumference of the circle).

With reference to Fig. 3, branches 1-2 form the top arm of the vertical dipole, and branches 3-4 form its bottom arm. Branches 5-6 form the left arm of the horizontal dipole, and branches 7-8 form its right arm.

10

Conductor 9 connects branches 1 and 5 belonging to the vertical and horizontal dipoles respectively. The first end portion 1a of conductor 9 is placed between branches 1 and 2. The second end portion 5a of conductor 9 is placed between branches 5 and 6. Conductor 10 connects branches 2 and 7 belonging to vertical and horizontal dipoles respectively. The first end portion 2a of conductor 10 is placed between branches 1 and 2. The second end portion 7a of conductor 10 is placed between branches 7 and 8. Conductor 11 connects branches 4 and 8 belonging to vertical and horizontal dipoles respectively. The first end portion 4a of conductor 11 is placed between branches 3 and 4. The second end portion 8a of conductor 11 is placed between branches 7 and 8. Conductor 12 connects branches 3 and 6 belonging to vertical and horizontal dipoles respectively. The first end portion 3a of conductor 12 is placed between branches 3 and 4. The second end portion 6a of conductor 12 is placed between branches 5 and 6.

The end portion 1a of conductor 9 and the end portion 2a of conductor 10 are separated by gap 13. The end portion 7a of conductor 10 and the end portion 8a of conductor 11 are separated by gap 16. The end's portion 4a of conductor 11 and the end portion 3a of conductor 12 are separated by gap 14. The end portion 6a of conductor 12 and the end portion 5a of conductor 9 are separated by gap 15.

Feeding lines shown in Fig. 2b are connected to the vertical dipole at points 17 and 18 and to the horizontal dipole at points 19 and 20. The radiating arrangement excited in this way radiates two mutually perpendicular electrical fields: vertical E1 and horizontal E2.

The dual-polarized radiator according to embodiments of the invention contains three kinds of radiating elements. The first radiating element is the dipole arms. The second radiating element is a cruciform slot formed by the branches of crossed dipoles and the middle parts of the outer conductors connecting these branches. The third radiating element is formed by

two end portions of adjacent outer conductors and the two branches connected to them. Thus, the radiating arrangement according to embodiments of the invention is a small antenna array containing different radiating elements coupled with each other.

5 The dual-polarized radiator according to embodiments of the invention provides improved return loss or wider frequency band in comparison with conventional solutions, with the result that it is possible to change impedances and resonant frequencies of three kinds of radiating elements by changing its shape and match this radiator with feeding transmission line over a wide frequency band.

10

The dual-polarized radiator according to embodiments of the invention also provides less beamwidth in the H plane in comparison with conventional crossed dipoles since outer conductors forming outer contour of a radiating arrangement increase width of a radiating structure in the H plane.

15

Outer contour of the radiating arrangement, the conductive plate and a dielectric body having circle or octagonal shape form a beam having almost equal beamwidth in E plane and H plane therefore a spherical lens antenna illuminated by this radiator also forms a beam having almost equal beamwidth in E plane and H plane.

20

A dielectric body acts as a small lens concentrating RF energy. Dimensions of a dielectric body are less than wavelength at low frequency of operating frequency band therefore its influence on beamwidth doesn't sufficient at low frequency and increases with frequency. As a result beamwidth of the dual-polarized radiator according to embodiments of the invention has more dependence versus frequency in comparison with conventional solutions. A dielectric body 100 shown in Fig. 2a is made in a shape of a cut cone but it is possible to use other shapes, for example a cone of a half of sphere, to increase dependence of beamwidth versus frequency.

25

30 A dielectric body partly reflects RF energy radiated by a radiating arrangement therefore it is difficult to match a radiating arrangement with feeding line over a wide frequency band if a dielectric body made of material having dielectric constant more than 2.5. A relatively small dielectric body having dielectric constant less than 1.2 doesn't create considerable influence on beamwidth. Therefore a dielectric body having dielectric constant between 1.2 and 2.5 gives the best result. The dielectric body 100 shown in Fig. 2a was made of a light artificial dielectric material having dielectric constant 1.6. Weight of dielectric body 100 is less than 80

35

Gramm therefore four thin dielectric spacers 102 are enough to support one above a radiating arrangement.

Conductive strips excited by outer contours radiates mainly at high frequencies of operating frequency band since ones have length less than quarter wavelength at low frequency. A conductive plate and side walls reflect radiation of conductive strips and direct one to a main beam formed by a radiating arrangement. Thus conductive strips act together with a radiating arrangement and increase dimensions of radiating area at high frequencies of operating frequency band. As a result beamwidth of the dual-polarized radiator according to embodiments of the invention has more dependence versus frequency in comparison with conventional solutions.

Another option is for the radiating arrangement and the feeding element to be manufactured as a single part by die-casting. Direct contact between the feeding element and a reflecting conductive plate could generate passive intermodulation products. The other embodiment of the dual polarized radiator shown in Fig. 4 in the cross section through the center and a feeding coaxial cable gives a chance to avoid generation of passive intermodulation products. Conductors 67-70 of the feeding element are made as one part with the radiating arrangement 101 and an additional conductive plate 97 separated from a reflecting conductive plate 103 by a dielectric film 98.

A sample of the dual polarized radiator was manufactured according to embodiments of the present invention to operate over 1710 to 2690 MHz frequency band. Isolation between polarizations was more than 34 dB and VSWR better than 1.3. Co polar and cross polar radiation patterns of this sample are shown in Fig. 5a and 5b respectively. Half power beamwidth and beamwidth at -10 dB power are shown in Fig. 5a as BW(3) and BW(10) respectively.

A ratio of maximum frequency to minimum frequency of operating frequency band 1710-2690 MHz is $F_{\max}/F_{\min}=2690/1710=1.57$.

$BW(3)_{\min}/BW(3)_{\max}$ ratio of radiation patterns shown in Fig. 5a is $60.8/35.6=1.71$ and $BW(10)_{\min}/BW(10)_{\max}$ ratio is $110.9/61.2=1.81$.

Thus the dual polarized radiator was manufactured according to embodiments of the present invention forms a beam having beamwidth varying approximately inversely with frequency.

The dual-polarized radiator according to embodiments of the present invention further provides narrower beamwidth in comparison with log-period dipole arrays and tapered notch antennas therefore less RF power penetrates in other placed nearby radiators. As a result placed nearby dual-polarized radiators according to embodiments of the invention are better isolated from each other than mentioned above feeds. Therefore the dual-polarized radiator according to embodiments of the invention better suits to be used as a feed for multi beam lens antennas.

A multi beam antenna containing dual polarized radiators according to embodiments of the present invention is shown in Fig. 6 in a schematic top view. Twelve dual polarized radiators 31-42 are placed around a spherical Luneberg lens 30 having diameter 1.8 m. The lens 30 made of a light artificial dielectric material contains several layers having different dielectric constant. This antenna covers 120 degree sector by 12 beams having the power level at crossover points between adjacent beams approximately -10 dB with variation less than +/-4 dB over 1710 to 2690 MHz frequency band. Co polar and cross polar radiation patterns of one beam of this antenna are shown in Fig. 7a and 7b respectively where in $BW(10)_{max} = 11.7$ degree at 1710 MHz and $BW(10)_{min} = 9.5$ degree at 2690 MHz max. A cross polarization of each beam is better than -16 dB.

The manufactured sample of 12 beam lens antenna provides VSWR better than 1.4 and isolation better than 30 dB between +/-45 degree slant polarization of each beam and better than 28 dB between beams over 1710 to 2690 MHz frequency band.

While the present invention has been illustrated by the description of the embodiments thereof and while the embodiments have been described in detail, it is not the intention of the Applicant to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details, representative devices and illustrative examples shown and described. Accordingly, departures may be made from such details without departure from the spirit or scope of the Applicant's general inventive concept.

CLAIMS

1. A dual polarized radiator comprising:

a radiating arrangement, a feeding element containing two feeding lines and forming two
 5 perpendicular baluns supporting the radiating arrangement above a reflective conductive
 plate containing side walls, a dielectric body and four directing conductive strips;

wherein the radiating arrangement comprises two crossed dipoles connected by four
 outer conductors forming an outer contour of the radiating arrangement in a shape of a
 circle or an octagon;

10 wherein each crossed dipole comprises two dipole arms, each dipole arm contains
 two equal branches connected together at a point of connection between the dipole arm
 and one of the two feeding lines;

wherein a first gap between two equal branches of each dipole arm and a second gap
 between adjacent branches of different dipole arms increase toward the outer contour of
 15 the radiating arrangement;

wherein each outer conductor contains a middle portion and two end portions;

wherein the middle portion connects the adjacent branches of the different dipole
 arms with the two end portions;

20 wherein a first end portion is placed between the branches of one dipole arm and a
 second end portion is placed between the branches of an adjacent dipole arm;

wherein one end portion of one outer conductor and the other end portion of an
 adjacent outer conductor are placed between the branches of one of the dipole arm, and
 are separated from each other by a third gap creating a capacitive coupling between the
 two adjacent outer conductors;

25 wherein the dielectric body is placed above the radiating arrangement;

wherein the four directing conductive strips are placed above the reflective conductive
 plate and below the radiating arrangement and each directing conductive strip is placed
 in parallel to the middle portion of one of the outer conductors between the said middle
 portion and a side wall of the reflective conductive plate; and

30 wherein said radiator forms a beam having beamwidth varying inversely with
 frequency or at least having a minimal deviation from this dependence.

2. A dual polarized radiator according to claim 1, wherein the reflective conductive plate
 is made in a shape of a circle or an octagon.

3. A dual polarized radiator according to claim 1, wherein the dielectric body is made in
 a shape of a cut cone.

4. A dual polarized radiator according to any preceding claim, wherein the dielectric body is made of a material having dielectric constant less than 2.5 and more than 1.2.
5. A dual polarized radiator according to any preceding claim, wherein the dielectric body is made of a light artificial material.
6. A dual polarized radiator according to any preceding claim, wherein the radiating arrangement is formed from a single sheet of conductive material.
7. A dual polarized radiator according to any preceding claim, further comprising a thin dielectric film placed between the feeding element and the reflecting conductive plate.
8. A dual polarized radiator according to any preceding claim, wherein the reflective conductive plate is made in a shape of a circle or an octagon.
9. A dual polarized radiator according to any preceding claim, wherein a distance between the radiating arrangement and the reflective conductive plate is smaller than 0.25 wave length corresponding to a middle operating frequency.
10. A dual polarized radiator according to any preceding claim, wherein said radiator is placed nearly a surface of a dielectric lens to create an antenna forming a beam having a minimal beamwidth deviation as a function of frequency.
11. A dual polarized radiator according to any preceding claim, wherein plurality of said radiators are placed nearly a surface of a spherical Luneberg lens to create a multi beam base station antenna forming a set of beams having a minimal deviation of a power level at crossover points between adjacent beams.