



Europäisches Patentamt
European Patent Office
Office européen des brevets

Publication number:

**0 134 688
B1**

12

EUROPEAN PATENT SPECIFICATION

45 Date of publication of patent specification: **30.03.88**

51 Int. Cl.⁴: **H 01 Q 11/06, H 01 Q 9/26**

21 Application number: **84305136.8**

22 Date of filing: **27.07.84**

54 **Rhombic aerial.**

30 Priority: **28.07.83 GB 8320420**

43 Date of publication of application:
20.03.85 Bulletin 85/12

45 Publication of the grant of the patent:
30.03.88 Bulletin 88/13

84 Designated Contracting States:
DE FR GB

58 References cited:
GB-A- 906 301
US-A-2 285 565
US-A-4 005 430

73 Proprietor: **UNIVERSITY OF EXETER**
Northcote House The Queen's Drive
Exeter Devon EX4 4QJ (GB)

72 Inventor: **May, Eric John Patrick**
1, Belvidere Road
Pennsylvania Exeter Devon (GB)

74 Representative: **Calderbank, Thomas Roger**
et al
MEWBURN ELLIS & CO. 2/3 Cursitor Street
London EC4A 1BQ (GB)

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European patent convention).

Courier Press, Leamington Spa, England.

EP 0 134 688 B1

Description

This invention relates to rhombic aerials for radio transmission and reception, and is more particularly applicable to the manner in which connections are made to such aerials.

A standard rhombic aerial consists of two active elements in the form of wires having a section in which they are close together and a section in which the wires from two arms which first diverge at the same angle and then converge to a connection point, so that the latter section is in the shape of a rhombus. Such rhombic aerials are disclosed in e.g. US—A—2285565, pages 4-30 to 4-35 of "Antenna Engineering Handbook" edited by H. Jasik published by McGraw Hill in New York in 1962, and pages 8 and 9 of the 1949 edition of "Microwave Antenna Theory and Design" edited by S. Silver.

In a rhombic aerial it is important that only travelling waves are generated, and to suppress standing waves it is usual for there to be a resistor connecting the wires at the connection point. This resistor, which usually has a resistance of about 600Ω to 800Ω, absorbs the electrical power that the aerial has not converted to a travelling wave and would otherwise set up a standing wave. In a standard rhombic aerial the power dissipated by the resistor may be up to 60% of the power input to the aerial, but despite the disadvantage of power loss, the rhombic aerial is desirable because of its large bandwidth.

It is believed that all known rhombic aerials use relatively thin wires to form the arms; the reason for this being that at high frequencies the size of aerial must be large. However, a wire aerial is difficult to support and hence is unsuitable for commercial applications. It was therefore not possible to utilize the large bandwidth of the rhombic aerial at VHF and UHF frequencies e.g. for television.

The inventor of the present application decided to use conductive tubes, bent at a suitable angle, to form the active elements of the rhombus. The rigidity of the tubes enabled the aerial to be self-supporting. When tubes were used a number of other developments were found possible and these will now be discussed.

In using a rhombic aerial for domestic use, e.g. on a television aerial, it is desirable that the input transmission lines are in the form of a co-axial cable. When an aerial with tubular conductors was connected to a co-axial cable it was found that the outer conductor of the cable acted as an extension of the arm of the aerial to which it was connected, causing the performance of the aerial to deteriorate.

Various devices including transformers and co-axial transmission line baluns were investigated in attempts to overcome this problem. These are often inefficient and there may be a heat dissipation problem. They also have the disadvantage of reducing the bandwidth of the aerial.

It was realized that it was not necessary for the conductors forming the cable to extend away

from the aerial from the end of the arms to which electrical connection was made but could extend away from any point on the "neutral plane", the plane about which the aerial is balanced. It was appreciated that the conductors could enter the aerial at the resistor end and pass through an adjacent one of the arms to the end at which connection between the arms and the cable is made.

Therefore, the present invention provides a rhombic aerial having two active elements in the form of conductive arms together forming a rhombus, one pair of adjacent ends of the active elements having a gap therebetween and each end of the pair being connected to a corresponding conductor of a transmission line, the other pair of adjacent ends of the active element being connected together by a resistor; characterized in that:

the resistor is tubular, the transmission line enters the resistor through a hole in the tube, and extends along a path from the resistor, substantially the whole of the path being at least partially enclosed within an active element, such that one of the conductors of the transmission line forms a part of that active element.

This idea of passing the conductors through an arm of an aerial has been disclosed in connection with folded dipole aerials in GB—A—906301 and US—A—4005430, but the problems of such aerials are different. The main difference is that a folded dipole aerial is a standing wave device, whereas in a rhombic aerial it is important to minimise or eliminate standing waves. Also in a folded dipole there is only one active element, the two "arms" are continuous and there is no resistor to complicate the connection.

The properties of a rhombic aerial with tubular arms and with the cable passing through one of those arms were investigated and it was found that the aerial was considerably more efficient than known rhombic aerials at converting input power to travelling waves. The 60% loss from the resistor dropped to less than 10%. The reasons for this were investigated and it was found that the use of an active element with a relatively large cross section (as compared with a wire) reduced the impedance of the aerial and this caused a significantly greater amount of power to be transmitted, so that less power reached the resistor. It was found that the tubular shape of the arms was not essential; the arms could be elliptical, rectangular or channel shaped, the important factor being that the active elements should have a relatively large cross section. In the case of a channel the cable would be led within the channel.

The improved efficiency of the rhombic aerial according to the present invention has the additional advantage that the value of the resistance of the resistor is less critical than in a standard rhombic aerial, and indeed satisfactory performance can be obtained with almost any resistance, although a resistance of about 200Ω has been found to give good results.

The resistor is a tubular resistor with a hole

through which passes the cable containing the conductors. Such a tubular resistor may be fabricated by coating a hollow tubular insulator with conductive material.

An embodiment of the invention will now be described by way of example, with reference to the accompanying diagrammatic drawing in which the sole figure is a plan view of a rhombic aerial according to the present invention.

The aerial in the figure comprises two arms formed by lengths of hollow tube 34, 35 having 130° bends 36 and arranged in rhombic form. The angle of the bends 36 is an important factor in determining the performance of the aerial. The precise value selected depends on the wavelength and the aerial dimensions, but can be determined in a known way. The bends 36 are spaced apart and supported by a plastics support member 38. At the non-connection end 40 of the aerial, the tubes 34, 35 are connected together by a tubular resistor 42 and secured by a plastics nut 44 and bolt 46. The tubular resistor 42 is preferably made by coating a hollow cylindrical insulator with an external coating of conductive material, e.g. by sputtering or printing. The resistance of the resistor 42 may be selected to suit the use of the aerial, and in special cases may be infinite (an insulator) or negligibly small. Preferably, however, the resistance of the resistor 42 is between 100Ω and 300Ω, and 200Ω is often a suitable value. The earth plane of this aerial is indicated by the dotted line 48. Unlike a prior art rhombic aerial, little power is dissipated by the resistor 42 when the aerial is used as a transmission aerial, and so the cooling methods used in the prior art may be unnecessary.

In accordance with the present invention, the signal feed to or from the aerial comprises a co-axial cable 18 which passes through a hole in the resistor 42, in the earth plane 48, and thence along the interior of the tube 34 to the connection points at the far end of the aerial. Here, the outer conductor of the cable is connected to the tube 34 e.g. by a suitable screw connected and the inner conductor 22 passes through an opening at the end of tube 34, extends across the gap between the ends of the tubes 34 and 35 and is connected to the tube 35 e.g. a suitable screw connector.

It will be appreciated that the only point at which the cable 18 leaves the earth plane it is enclosed within the tube 34 or within the resistor 46 and therefore its outer conductor effectively forms part of the active element, and cannot act as a spurious aerial or otherwise unbalance the system.

The illustrated embodiment may be modified without losing the advantages of the present invention. For example, it would be possible to use channel shaped sections to form the arms of the rhombus, with the cable 18 passing within the U-section of the channel. It would even be possible to use solid arms, with the cable being secured in close proximity to one of them. The material of the arms can be any conductive material; metals such as copper or aluminium are suitable, and conductive plastics materials have been developed which are particularly advantageous, due to their

lightness. It is also possible to use one of the conductors as the active element e.g. by removing the outer insulation from a co-axial cable or by using known strip conductors in which a pair of flat outer conductors are separated by insulation from an inner conductor.

The embodiment described above is supported by a support member 38 extending between the arms 34, 35. It would also be possible for the support member to extend from the resistor 42 to the connection end of the aerial, or even for the aerial to be supported from the tubular resistor itself.

Claims

1. A rhombic aerial having two active elements in the form of conductive arms (34, 35) together forming a rhombus, one pair of adjacent ends of the active elements having a gap therebetween and each end of the pair being connected to a corresponding conductor of a transmission line (18), the other pair of adjacent ends of the active element being connected together by a resistor (42); characterised in that: the resistor (42) is tubular, the transmission line enters the resistor (42) through a hole in the tube, and extends along a path from the resistor (42), substantially the whole of the path being at least partially enclosed within an active element, such that one of the conductors of the transmission line (18) forms a part of that active element.

2. A rhombic aerial according to claim 1, wherein the arms (34, 35) are hollow conductive tubes and the transmission line passes through the interior of one of the tubes (34).

3. A rhombic aerial according to claim 1, wherein the arms (34, 35) are conductive channels and the transmission line passes within the channel of one of the arms (34).

4. A rhombic aerial according to claim 1, wherein one of the active elements is formed by a conductor of the transmission line (18).

Patentansprüche

1. Rhombusantenne mit zwei aktiven Elementen in Form von leitfähigen Armen (34, 35), die miteinander einen Rhombus bilden, wobei sich zwischen zwei benachbarten Enden der aktiven Elemente ein Spalt befindet und jedes dieser beiden Enden mit einem entsprechenden Leiter einer Übertragungsleitung (18) verbunden ist und die beiden anderen benachbarten Enden der aktiven Elemente über einen Widerstand (42) miteinander verbunden sind, dadurch gekennzeichnet, daß der Widerstand (42) rohrförmig ist, daß die Übertragungsleitung durch ein Loch in dem Rohr in den Widerstand (42) eintritt und sich vom Widerstand (42) längs einer Bahn erstreckt, wobei die gesamte Bahn zumindest teilweise von dem aktiven Element umschlossen ist, so daß einer der Leiter der Übertragungsleitung (18) einen Teil dieses aktiven Elements bildet.

2. Rhombusantenne nach Anspruch 1, wobei die

Arme (34, 35) hohle leitfähige Rohre sind und sich die Übertragungsleitung durch das Innere eines der Rohre (34) erstreckt.

3. Rhombusantenne nach Anspruch 1, wobei die Arme (34, 35) leitfähige Kanäle sind und sich die Übertragungsleitung in dem Kanal eines Armes (34) erstreckt.

4. Rhombusantenne nach Anspruch 1, wobei eines der aktiven Elemente von einem Leiter der Übertragungsleitung (18) gebildet ist.

Revendications

1. Antenne en losange ayant deux éléments actifs sous la forme de bras conducteurs (34, 35) formant ensemble un losange, une paire d'extrémités adjacentes des éléments actifs ayant un écartement entre elles et chaque extrémité de la paire étant connecté à un conducteur correspondant d'une ligne de transmission (18), les deux autres extrémités adjacentes de l'élément actif

étant connectées par une résistance (42); caractérisée en ce que la résistance (42) est tubulaire, la ligne de transmission entre dans la résistance (42) par un trou dans le tube et s'étend le long d'un trajet à partir de la résistance (42), sensiblement la totalité du trajet étant au moins partiellement enfermée dans un élément actif, de manière que l'un des conducteurs de la ligne de transmission (18) fasse partie de cet élément actif.

2. Antenne en losange selon la revendication 1, où les bras (34, 35) sont des tubes conducteurs creux et la ligne de transmission traverse l'intérieur de l'un des tubes (34).

3. Antenne en losange selon la revendication 1, où les bras (34, 35) sont des gorges conductrices et la ligne de transmission passe dans la gorge de l'un des bras (34).

4. Antenne en losange selon la revendication 1, où l'un des éléments actifs est formé par un conducteur de la ligne de transmission (18).

25

30

35

40

45

50

55

60

65

4

