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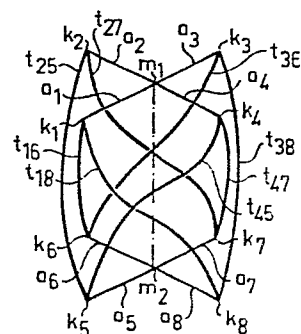
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**Transmitter-receiver system in a satellite.**

A transmitter-receiver system is included as a radio link in a satellite for transmitting and receiving signals in the micro-frequency range between two earth stations. The antenna in the system comprises, in accordance with the invention, an octofilar, crossed helix antenna, which is circularly polarised and practically omnidirectional with respect to radiated power.

**Fig.3**



TRANSMITTER - RECEIVER SYSTEM IN A SATELITE

## TECHNICAL FIELD

The invention relates to a transmitter-receiver system, which as a link in a satellite will receive and transmit signals in the microwave range between one earth station and another earth station. More specifically the invention relates to a transmitter-receiver system in which a new type of omnidirectional  
5 circularly polarised aerial or antenna is included.

## BACKGROUND ART

It is already known to use a so-called quadrifilar helix aerial, i.e. an omnidirectional aerial, mainly consisting of four longitudinal wires, which constitute the antenna radiation element and which are twisted round the longitudinal axis of the aerial, as described in "The Microwave Journal" December, 1970, pp 49-53.  
10 Such an omnidirectional antenna has a relatively large lobe width ( $O > 90^\circ$ ), making it suitable for satellite communication.

## DISCLOSURE OF INVENTION

In certain cases, however, extremely high coverage ( $O \geq 120^\circ$ ) is required from the aerial, so that the satellite may be reached by signals in its orbit, relatively independently of its own orientation to the earth's surface. At the same time  
15 there is a desire for the aerial to have high cross polarisation, as well as large bandwidth (200 MHz at 2 GHz), i.e. it must be able to link radio signals that are both right (RHC) and left polarised (LHC) with retained large coverage ( $O$  is still large). Figure 1 on the accompanying drawing illustrates a typical aerial diagram for the known quadrifilar helix aerial (field strength FS as a function of  
20 the angle  $O$  from the antenna axis). It will be seen from the diagram that the antenna has good coverage for right-hand polarised interference signal, almost up to  $120^\circ$  width in this case, but that a left-hand polarised interference signal also occurs at lobe angles around  $90^\circ$ , since this signal does not contribute further to the lobe width.

If the earth station is capable of receiveing (or transmitting) both left and right polarised signals at the same time, high cross polarisation could be useful. Most earth stations can receive both types.

5 According to the proposed invention, the antenna in the transmitter-receiver system it is included in, is formed as an octofilar crossed helix antenna, resulting in that there is obtained the desired high cross polarisation, apart from the normal polarisation. This means that the coverage increases in relation to the quadrifilar helix antenna, since the octofilar antenna has a lobe diagram for left polarised signals (LHC) even when  $\theta > 120^\circ$ . There is thus  
10 obtained a system with a practically completely omnidirectional antenna with respect to radiated power.

The proposed transmitter-receiver system is implemented as will be perceived from the characterising portion of claim 1.

#### BRIEF DESCRIPTION OF DRAWINGS

The invention will now be described in detail, with reference to the accompany-  
15 ing drawing, where Figure 1 is a lobe diagram for a known quadrifilar antenna.

Figure 2 is a block diagram of the transmitter-receiver system in accordance with the invention.

Figure 3 schematically illustrates the construction of the antenna included in the system in Figure 2.

20 Figure 4 illustrates a conventional adaptor unit included in the system in Figure 1.

Figure 5, in correspondence with Figure 1, is a lobe diagram for antennas included in the system in Figure 2.

## BEST MODES FOR CARRYING OUT THE INVENTION

A first and a second transmitter-receiver unit are respectively denoted by SM1 and SM2 in the block diagram according to Figure 2. These units are conventional and are connected in a suitable way to a directional switch RK (3dB hybrid). Both outputs of the switch are connected to an adaptor unit BL, a so-called  
5 "balun", which diverts the signals sent from the switch to four outputs in this case, from which signals with different phase shifts  $0^{\circ}$ ,  $90^{\circ}$ ,  $180^{\circ}$  and  $270^{\circ}$  are obtained. The balun BL, shown in detail in Figure 4, further serves as mechanical support for the antenna unit AN, which is shown in more detail in Figure 3. This unit is an octofilar crossed helix antenna, which has the property of  
10 transmitting and receiving cross-polarised signals, such that it acts omnidirectionally within a given angle  $\Theta$ . The fact that the antenna unit AN has high cross polarisation enables both right and left polarised signals to be processed by the system, providing that both types of signals can be processed simultaneously or individually by the earth station. The transmitter-receiver unit SM1  
15 may be intended for the right-hand polarised (RHC) signals as chief polarisation, while the unit SM2 is then intended for the left-hand polarised (LHC) signals as chief polarisation. The directional switch RK equally divides the power from a transmitter-receiver unit on its two outputs, mutually phase-shifted  $90^{\circ}$ . If, for example, the unit SM1 is connected to the port in the  
20 directional switch RK that gives right-hand polarisation (RHC) as chief polarisation (copolarisation), the radiation diagram for the antenna AN will have the appearance depicted in Figure 5. The radiation diagram from the unit SM2, which is then connected to the other input of the switch RK, will have the appearance as in Figure 5, except that the denotations RHC and LHC change  
25 places. Which SM unit is used depends on the application, but most usual is that SM2 replaces SM1 if the latter fails, i.e. a redundant system. It is, however, quite possible to use both transmitter-receiver units simultaneously.

In previously known systems, which use a quadrifilar helix as antenna unit, the use of a three-port electromagnetic switch is necessary, the switch being  
30 connected between both units SM1 and SM2 and the switch RK for switching in the unit to be utilised. In this case only one polarisation is utilised, right or left, and chief polarisation will remain the same irrespective of what SM unit is used (c.f Figure 1). This switch is not needed in the inventive system, since both left

and right polarised signals have equivalent lobe coverage (c.f. Figure 5). In one case the right-hand circularly polarised field is the chief polarisation, and in the other, the left-hand circularly polarised field. That the switch is dispensed with, considerably increases the system reliability.

- 5 Figure 3 illustrates the appearance of the antenna unit AN in more detail. As mentioned, this is an octofilar crossed helix antenna, in contradistinction to previously known systems, in which a quadrifilar helix was utilised. It may be said that the antenna is in principle built up from two crossing arms with a given mutual spacing. One pair of crossed arms  $a_1, a_3$  and  $a_2, a_4$  define an upper antenna plane with end points  $k_1-k_4$ , and the other pair  $a_5-a_7$  and  $a_6, a_8$  defines a lower antenna plane with end points  $k_5-k_8$ . The arms  $a_1-a_4$  in the upper plane and arms  $a_5-a_8$  in the lower are situated relative each other such that respective end points  $k_1-k_4$  and  $k_5-k_8$  are directly opposing, i.e. end point  $k_1$  is opposite  $k_5$ ,  $k_2$  is opposite  $k_6$  etc. Two wires run from each point in the upper plane to the end points in the lower plane, that are situated nearest before and nearest after the end point, opposite the first-mentioned end point. For example, the wires  $t_6$  and  $t_8$  run from the end point  $k_1$  to the end points  $k_6$  and  $k_8$  in the lower plane, the wires  $e_{25}$  and  $e_{27}$  run correspondingly from the end point  $k_2$  to the points  $k_5$  and  $k_7$ , the wires  $t_{36}$  and  $t_{38}$  from the end point  $k_3$  to end points  $k_6$  and  $k_8$ , and the wires  $t_{45}$ ,  $t_{47}$  run from the end point  $k_4$  to the points  $k_5$  and  $k_7$ . The octofilar helix antenna illustrated in Figure 3 may be said to consist of two quadrifilar helix antenna, of which one (antenna elements: wires  $t_8, t_{25}, t_{36}, t_{47}$ ) can receive left polarised, and the other (antenna elements: wires  $t_6, t_{27}, t_{38}, t_{45}$ ) can receive right polarised signals. The antenna radiation element thus comprises conductive wires (usually of copper), which depart in pairs from each of four end points  $k_1, k_2, k_3, k_4$  in a plane, the wires being bent and twisted with uniform pitch a quarter of a turn forwards or backwards, as respectively seen from each of the end points in the upper and lower planes of the antenna.
- 30 Figure 5 is the radiation diagram for the octofilar helix antenna according to Figure 3 with right-hand polarisation. It will be seen from the diagram that the antenna lobe angle for both left and right polarised signals is increased, particularly for left polarised signals (cross polarised), compared with the diagram of Figure 1. When the antenna field strength for right-hand polarised

signals (RHC) falls for lobe angles  $\theta$  between  $90^\circ$  and  $180^\circ$ , the radiation field strength of left-hand polarised (LHC) signals will increase instead, and first decline substantially for angles close to  $180^\circ$ . There is thus obtained good lobe coverage, at least up to  $\theta = 150^\circ$ . The location of the radiation lobes (field strength) in the  $\theta$  direction, may be changed for a given microfrequency by changing the radial distance  $r$  and/or the height  $h$ , the pitch angle  $\theta$  in Figure 3.

Figure 4 illustrates in detail how the octofilar helix antenna is arranged at its feed end (the upper antenna plane) as a balun. The four co-axial conductors  $b1-b4$  of the balun have their respective screens connected to a common earth or ground plane JP. The centre conductors are connected to the four arms  $a1, a4$ , of the helix antenna, these being split up in pairs and each pair bridged by a bridge  $b13$  and  $b24$ , respectively. Feeding the microwave signals to the four arms  $a1-a4$  is thus obtained, the arms being mutually relatively displaced by  $90^\circ$ . The antenna elements, i.e. the wires  $t8, t16$  etc, run from the respective end points  $k1-k4$  of the arms  $a1-a4$ , as illustrated in Figure 3. The end points  $k5, k6, k7$  and  $k8$  may be attached by the arms  $a5-a6$  to the balun ground plane JP in a suitable way, or by an unillustrated screen to the balun, e.g. as illustrated for the quadrifilar helix antenna, discussed in the above-mentioned article from "The Microwave Journal", see Figure 1.

The helix antenna radiation elements, i.e. the wires  $t6, t18$  etc, may each have a length equal to a multiple of  $2/2$ , so that they form a resonant antenna, which is the preferred embodiment. In some applications, however, it is advantageous to form the antenna as non-resonant.

The antenna may be manufactured according to known technique. It is very light with wide bandwidth, compared with a slitted wave conductor antenna. The inventive system is primarily intended as a link antenna in satellite projects concerned with so-called telemetry and tele command links.

CLAIMS

1. A transmitter-receiver system as a link in a satellite containing an omnidirectional circularly polarised aerial or antenna (AN), an adaptor unit (BL) for feeding the antenna elements with signals of suitable phase ( $0^{\circ}$ ,  $90^{\circ}$ ,  $180^{\circ}$ ,  $270^{\circ}$ ), a directional switch device (RK) for passing mutually phase-shifted signals ( $0^{\circ}$ ,  $90^{\circ}$ ) to the adaptor device (BL), and a transmitter-receiver part (SM1, SM2) for processing the signals received or transmitted by the antenna (AN), characterized in that the antenna (AN) is an octofilar helix antenna having four forwards twisted (t16,t27,t38,t45) and four backwards twisted (t18,t25,t36,t47) antenna elements for obtaining good lobe coverage with both right (RHC) and left polarised (LHC) signals.

2. System as claimed in claim 1, characterized in that the antenna (AN) comprises two pairs of crossed arms (a1-a4 and a5-a8) at given mutual spacing (d), and located so that the end points of the arms of each pair are placed substantially opposite each other, the antenna element comprising wires (t16-t47) arranged such that from the end points of one arm pair (a1-a4) a first wire (for example t16) runs from an end point (for example k1) to the end point (for example k6) of the other arm pair (a5-a8), the end point (k6), being situated opposite the nearest preceeding end point (k2), and a second wire (for example t18) runs from the first-mentioned end point (k1) to the end point (k8) of the other arm pair (a5-a8), such that this end point is nearest following after the end point (k1).

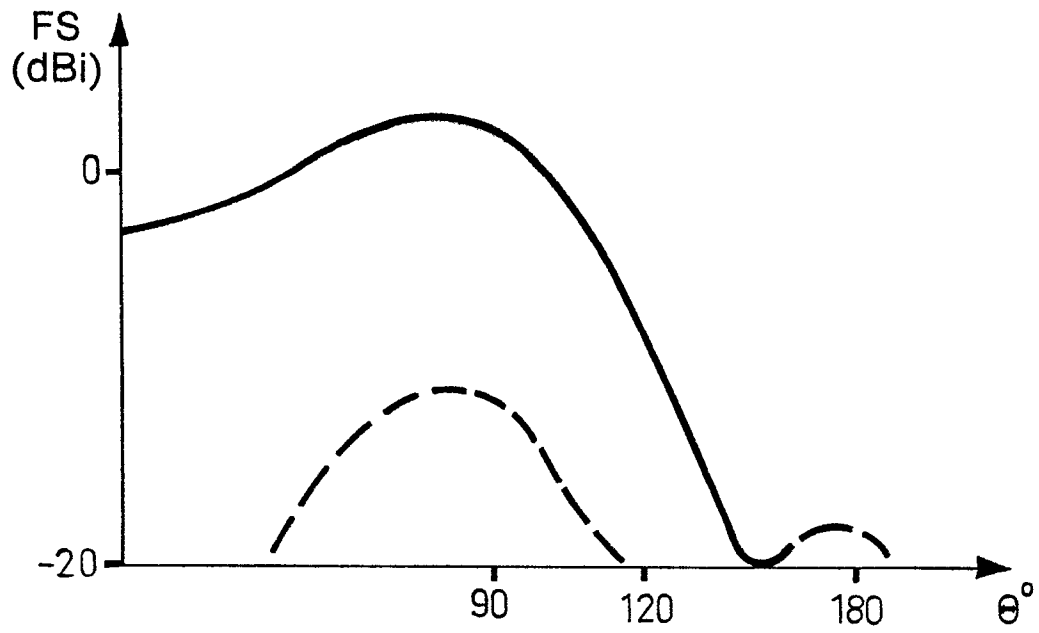
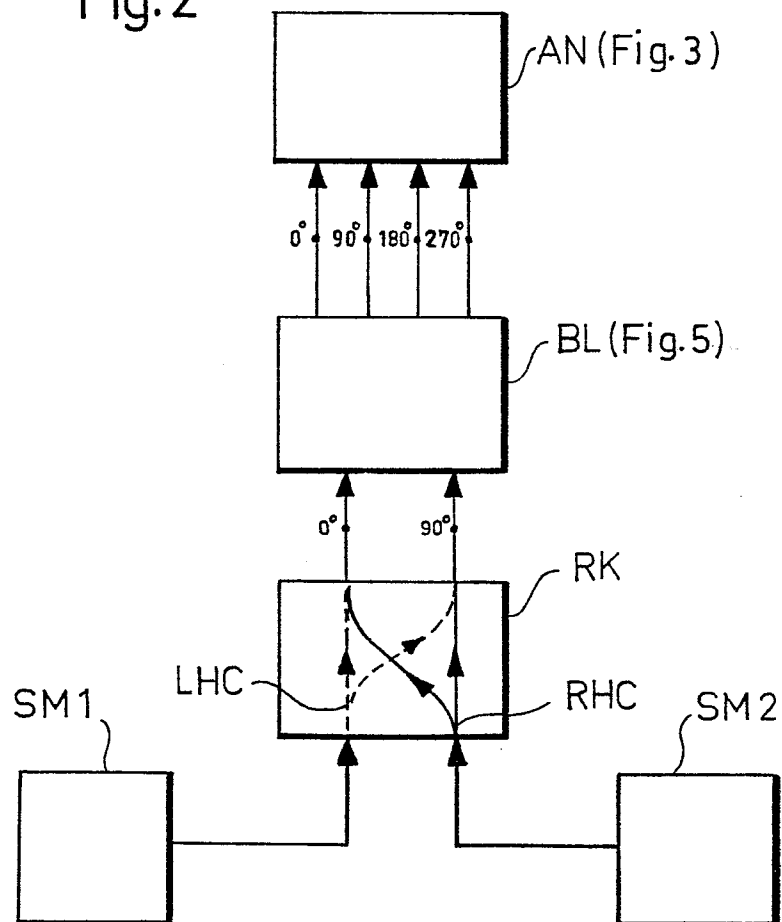
1/3  
Fig.1

Fig.2



2/3

Fig. 3

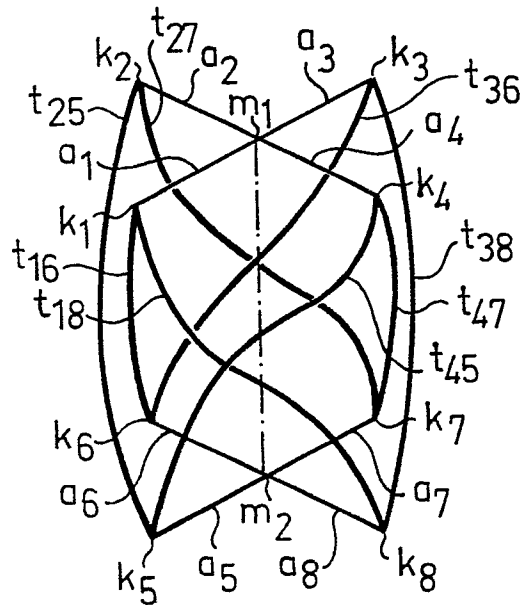


Fig. 4

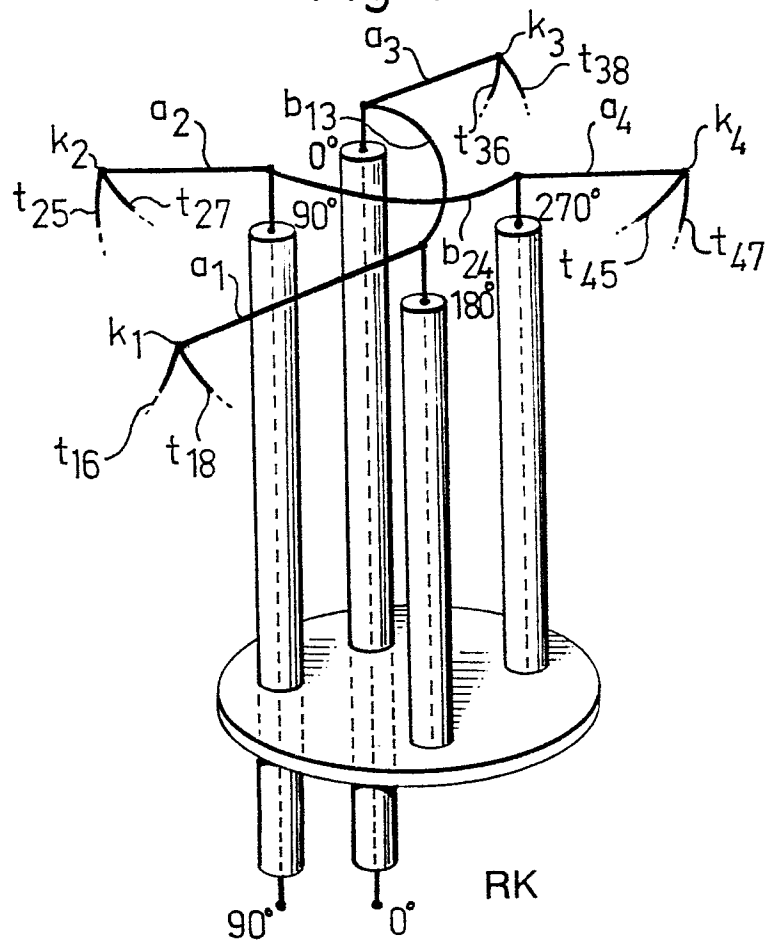
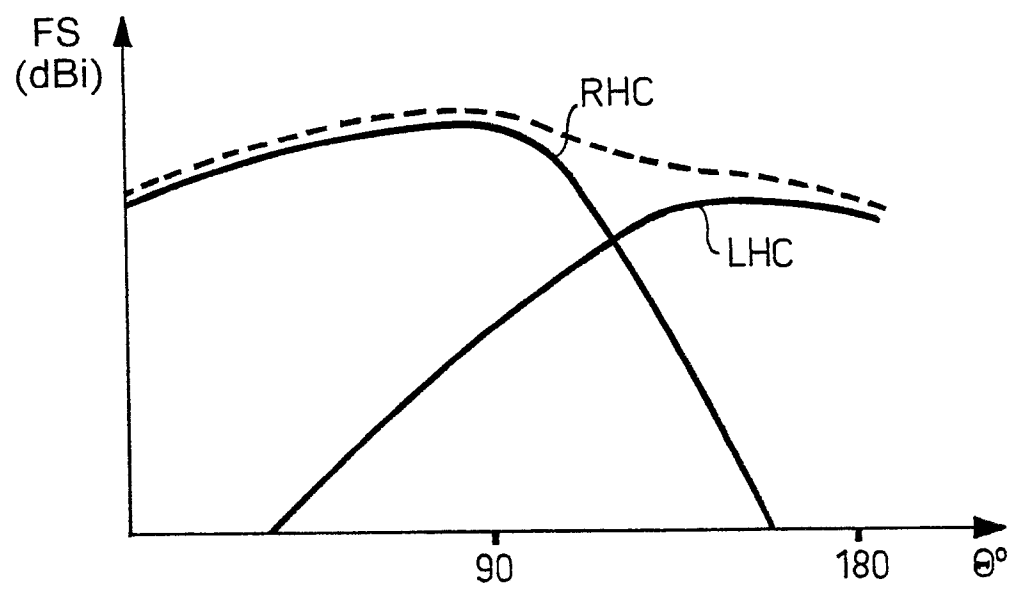


Fig. 5





| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                     |                                                                                                            |                                                                                                                                                                                                                                                                              |                                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|
| Category                                                                                                                                                                                                                | Citation of document with indication, where appropriate, of relevant passages                              | Relevant to claim                                                                                                                                                                                                                                                            | CLASSIFICATION OF THE APPLICATION (Int. Cl. 4) |
| A                                                                                                                                                                                                                       | US-A-4 011 567 (O BEN-DOV)<br>- - -                                                                        |                                                                                                                                                                                                                                                                              | H 04 B 7/185<br>H 01 Q 21/24<br>H 01 Q 11/08   |
| A                                                                                                                                                                                                                       | DE-B1-1 129 191 (SIEMENS & HALSKE AKTIENGESSELLSCHAFT)<br>- - -                                            |                                                                                                                                                                                                                                                                              |                                                |
| A                                                                                                                                                                                                                       | THE MICROWAVE JOURNAL, December 1970, pages 49-54, C. KILGUS: "Resonant Quadrifilar Helix Design"<br>- - - |                                                                                                                                                                                                                                                                              |                                                |
|                                                                                                                                                                                                                         |                                                                                                            |                                                                                                                                                                                                                                                                              | TECHNICAL FIELDS SEARCHED (Int. Cl. 4)         |
|                                                                                                                                                                                                                         |                                                                                                            |                                                                                                                                                                                                                                                                              | H 01 Q<br>H 04 B                               |
| The present search report has been drawn up for all claims                                                                                                                                                              |                                                                                                            |                                                                                                                                                                                                                                                                              |                                                |
| Place of search                                                                                                                                                                                                         |                                                                                                            | Date of completion of the search                                                                                                                                                                                                                                             | Examiner                                       |
| STOCKHOLM                                                                                                                                                                                                               |                                                                                                            | 27-09-1985                                                                                                                                                                                                                                                                   | MAGNUSSON G.                                   |
| CATEGORY OF CITED DOCUMENTS                                                                                                                                                                                             |                                                                                                            |                                                                                                                                                                                                                                                                              |                                                |
| X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document |                                                                                                            | T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>& : member of the same patent family, corresponding document |                                                |