May 13, 1952 K. POSTHUMUS 2,596,595

DIRECTIONAL ANTENNA SYSTEM

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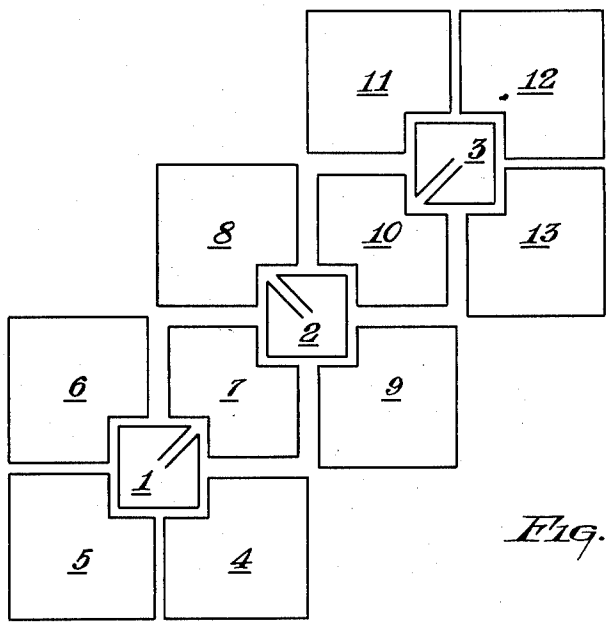
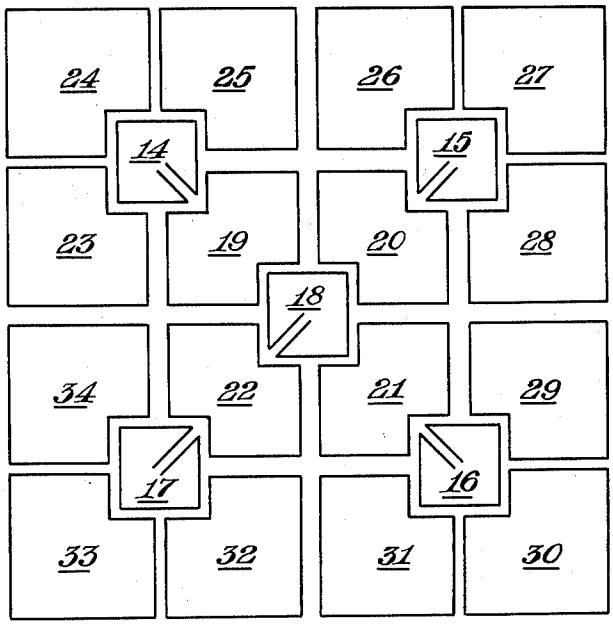


Fig. 1.

Fig. 2.



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DIRECTIONAL ANTENNA SYSTEM

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7 Claims. (Cl. 250—33.53)

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The invention relates to improvements in or modifications of the invention described and claimed in the copending U. S. application of the same inventor filed on January 16, 1948 and given Serial Number 2,774. In said application is described inter alia a frame aerial in which for the purpose of increasing the radiation resistance provision is made of a number of short-circuit turns extending from the coil periphery in an outward direction and occupying together an annular surface surrounding the coil former.

These short-circuit turns are preferably constituted by sector-shaped metal plates, operating as such, which for the sake of simplicity, will be referred to hereinafter as concentrator segments.

Frame aerials according to the above-identified copending application have the advantage of being of very simple construction. Furthermore, if the circumferential length of the frame aerial exceeds the operation wavelength, the natural frequency of the frame aerial may be materially higher than the frequency corresponding to the operation wavelength and the frame aerial exhibits remarkable favourable properties for transmission or reception of wide frequency bands of horizontally polarised energy.

The present invention relates to a further improvement of the frame aerials described in the copending application and may be applied with particular advantage, for example, to radio course-making transmitters in which carrier-wave energy and sideband energy are fed to different aerials for transmission with different directional diagrams.

According to the invention, in an aerial system comprising a number of frame aerials constructed in accordance with the description in the preamble to the copending application, the said aerials are located in one plane and adjacent frame aerials have at least one common short-circuit turn. The spacing between the center of adjacent frame aerials may thus be smaller than the sum of the corresponding spacings between the frame aerial centre and outer periphery of the annular surface occupied by associated short-circuit turns.

In known aerial systems for horizontal polarisation transmission with the use of various frame aerials, for example one central aerial and two aerials arranged one on each side thereof, use being made of aerials known as "Alford-loops," it was impossible, in view of the small permissible spacing between the outer aerials, to arrange the central aerial in the plane of the two other aerials in between and, in order to avoid radiation of

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undue polarisation the central aerial had to be "split up" into two aerials which were arranged respectively above and below the plane of the outer aerials.

The present invention permits of the frame aerials being as it were "intertwined" and dispenses with the "splitting up" of the central aerial.

In order that the invention may be more clearly understood and readily carried into effect, it will now be described more fully with reference to the accompanying drawing, in which Figs. 1 and 2 show, by way of example, two preferred embodiments of aerial systems according to the invention comprising respectively 3 and 5 frame aerials.

Fig. 1 shows an aerial system comprising three frame-aerial coils 1, 2 and 3, which is particularly suitable for use in beacon transmitters for guide plane indication by the amplitude-comparison method, the carrier-wave energy for unidirectional transmission being fed to the central frame-aerial coil 2 and energy modulated with the use of the outer frame aerials 1 and 3 by means of carrier-wave suppression and different signal frequencies (for example 90 and 150 c./s.) being transmitted with an eight-shaped directional diagram (beacon transmitter type SCS 51).

In order to increase the active frame surface area or else radiation resistance, each of the frame-aerial coils is surrounded by four concentrator segments co-operating therewith: coil 1 by segments 4 to 7, coil 2 by segments 7 to 10 and coil 3 by segments 10 to 13. These concentrator segments essentially transmit the current from a frame-aerial coil to the outer periphery of the associated segments.

Of these concentrator segments, the segments 7 and 10 are in common to the frame-aerial coils 1, 2 and 2, 3 respectively flanking these segments.

Since the aerials 1 and 3 with associated segments are arranged symmetrically to the central aerial, the outer aerials have no harmful effect on the central aerial. Otherwise, unduly tight couplings between the various frame-aerial coils with their associated concentrator segments are avoided by rendering the coupling between the two concentrator segments 7 and 10 which are in common to two frame-aerial coils and other concentrator segments less tight than the relative coupling between these other concentrator segments; this is achieved by suitable choice of the size of the gaps between the concentrator segments in the manner shown in Fig. 1. It should

be noted that the coupling between any concentrator segments and the corresponding frame-aerial coils is invariably made equally tight.

Fig. 2 shows an aerial system comprising 5 frame-aerial coils, four of which, to wit, 14, 15, 16 and 17, are arranged at the corners of a square and the fifth frame-aerial coil 18 being arranged centrally to the others. This aerial system is particularly suitable for transmission of a directional field of horizontally polarised energy rotating in a low-frequency rhythm, the carrier-wave energy being fed to the central aerial and the other aerials having fed to them the sideband energy produced by using carrier-wave suppression to cause phase-shifted signals to modulate the frequency corresponding with the desired rotation frequency.

The central frame-aerial coil is surrounded by four concentrator segments 19 to 22, each of which is, moreover, associated with one of the other frame-aerial coils 14 to 17, which have further concentrator segments 23 to 25, 26 to 28, 29 to 31 and 32 to 34. The coupling gaps between adjacent concentrator segments are chosen in a manner similar to that of Fig. 1 in accordance with the desired coupling.

The concentrator segments surrounding a frame-aerial coil may be subdivided, in the manner described in the copending application, in a tangential and/or a radial direction, if restriction of the natural frequency of the aerial system requires it or renders it desirable with a view to obtaining the mean operation frequency.

In the foregoing the connecting point of the supply leads for the various frame-aerial coils has not been discussed. In the two embodiments shown the supply conductors are diagrammatically shown and arranged so as to ensure minimum harmful effect on the shape of the desired radiation diagrams.

It is obvious that frame-aerial systems similar to the embodiments discussed may be used for receiving purposes, interalia for beacon receivers in which use is made of aerial systems for reception by the amplitude-comparison method with radiation diagrams overlapping one another or else for so-called rotary field receivers.

What I claim is:

1. A directional antenna system comprising a plurality of frame antenna structures each constituted by a centrally disposed open-circuited coil and a group of short-circuited loops inductively coupled to said coil and circumferentially arranged thereabout, the loops extending outwardly from the periphery of said coil and being shaped to define adjoining segments in an annular surface surrounding said coil, said frame aerial structures being disposed at adjacent positions in a single plane, adjacent structures having at least one short-circuited loop in common.

2. An arrangement, as set forth in claim 1, wherein the spacing between the center of the coil in one of said structures and the center of the coil in the adjacent structure is smaller than the sum of the corresponding spacings between the center of the coil and the outer periphery of the annular surface occupied by the short-circuited loops in said one of said structures.

3. An arrangement, as set forth in claim 1, wherein the coupling of short-circuited loops common to two frame aerial structures to other short-circuited loops is less than the coupling between these other short-circuited loops to one another.

4. A directional antenna system comprising a plurality of frame aerial structures each constituted by a centrally disposed open-circuited single turn coil, and a plurality of short-circuited loops formed by metallic plates inductively coupled to said coil and circumferentially arranged thereabout, the plates extending outwardly from the periphery of said coil and being shaped to define adjoining segments in an annular surface surrounding said coil, said frame aerial structures being disposed at adjacent positions in a single plane, adjacent structures having at least one plate in common.

5. A directional antenna system comprising three frame aerial structures each constituted by a centrally disposed open-circuited single turn coil and four metallic plates inductively coupled to said coil and circumferentially arranged thereabout, said plates extending outwardly from the periphery of said coil and being shaped to define adjoining segments in an annular surface surrounding said coil, said frame aerial structures being disposed at adjacent positions in a single plane, adjacent structures having one plate in common.

6. In a radio beacon for directional plane indication by the amplitude comparison method wherein carrier wave energy and side-band energy are transmitted by separate aerials, a directional antenna system comprising three frame aerial structures each constituted by a centrally disposed open-circuited coil and a plurality of short-circuited loops inductively coupled to said coil and circumferentially arranged thereabout, the loops extending outwardly from the periphery of said coil and being shaped to define adjoining segments in an annular surface surrounding said coil, one of said frame aerial structures being disposed at a given position in a single plane, said carrier wave energy being supplied to the coil in said one of said structures, the remaining two of said structures being arranged at either side of said one of said structures in said single plane, the side band energy being supplied to the coils in said remaining structures, each of the remaining structures having a short-circuited loop in common with said one of said structures.

7. A directional antenna system comprising five frame aerial structures each constituted by a centrally disposed open-circuited coil and four short-circuited loops inductively coupled to said coil and circumferentially arranged thereabout, the loops extending outwardly from the periphery of said coil and being shaped to define adjoining segments in an annular surface surrounding said coil, said structures being adjacently disposed within a single plane, the coils in four of said structures being disposed at the respective corners of a square, the coil in the fifth structure being disposed at the center of said square, each loop in said fifth structure being in common with one loop in each of the four of said structures.

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