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DIRECTIVE ANTENNA

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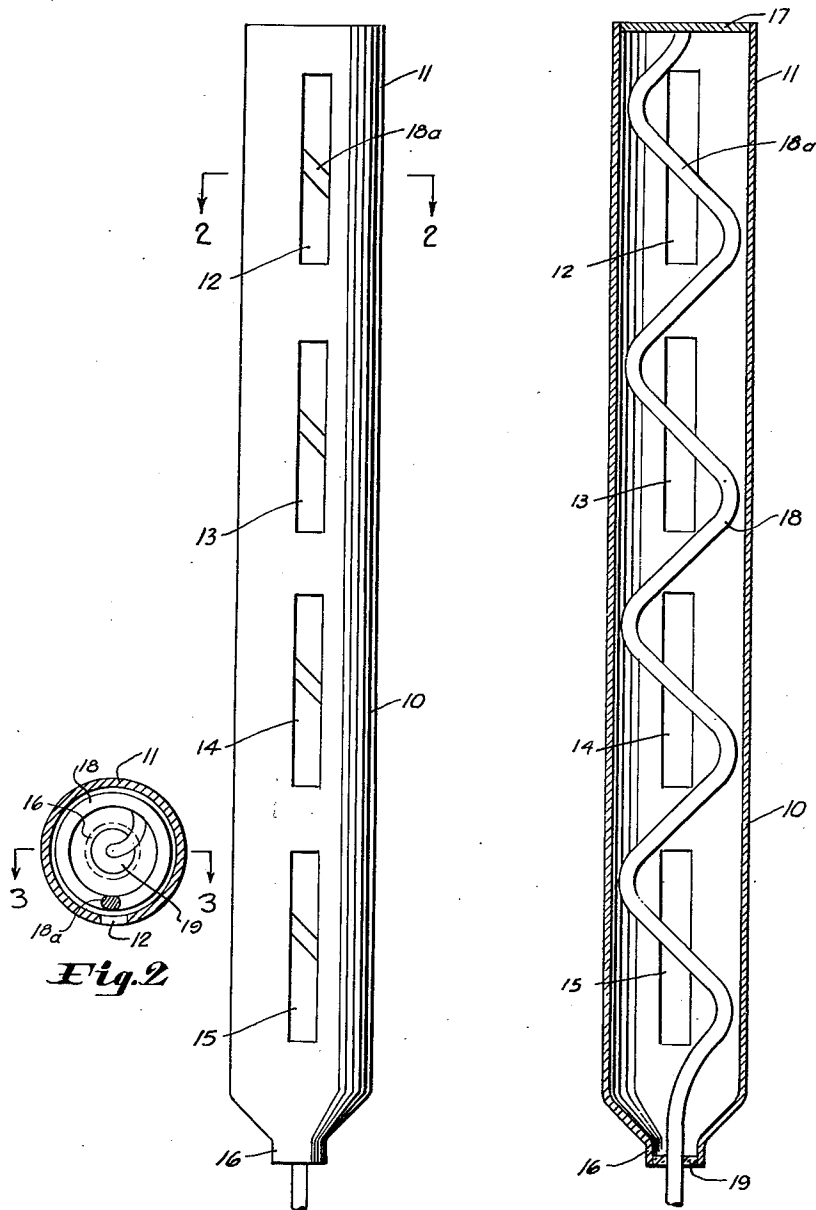


Fig. 1

Fig. 3

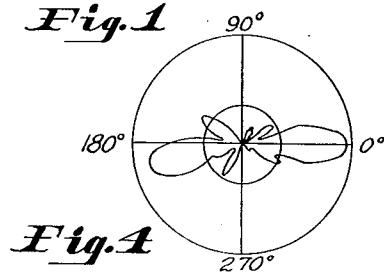


Fig. 4

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1

2,816,285

DIRECTIVE ANTENNA

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5 Claims. (Cl. 343—770)

This invention relates to directive antennas and in particular to those useful in providing a narrow powerful beam of substantially equal intensity in all aspects of azimuth. This invention relates more particularly to a slotted cylindrical antenna, especially useful for transmission in the V. H. F. and U. H. F. range of frequencies.

It has been indicated by prior art that putting a slot in a sheet of metal wherein the slot length equals one-half the wave length of the exciting medium allows the slot to act as a polarized radiator, if both sides of the slots are connected to the exciting source. As a consequence of this discovery, antennas have been prepared in the form of circular wave guides or co-axial lines containing axial slots in the outer conductor and exciting screws protruding inwardly from the slot towards the inner conductor in order to obtain the current flow necessary for excitation of the slots. Such accessory means as exciting screws are necessary to achieve excitation on the slots since the fields in a T. E. M. coaxial mode consist of E_z (electric field) and H_θ (magnetic field). These fields do not provide a component of current across the slot and so will not excite an axial slot except through the use of an arrangement, such as a screw, positioned just to the left or right of the slot.

In the present invention, a tubular co-axial line is used having a single array of axial slots in the outer conductor. The inner conductor is shaped in the form of a helix which provides a component of H_z (magnetic field) sufficient to induce transverse current across each slot. By proper choice of dimensions and positions in accordance with established radiation theory, the slots can be excited in phase for a particular desired wave length. This invention provides omni-directional radiation in azimuth with a substantially narrow beam in elevation. It is considered that the slots are connected in parallel.

This invention will be better understood by reference to a preferred embodiment in which:

Figure 1 is a frontal view of the antenna facing the slot array;

Figure 2 is a transverse section 2—2 of Figure 1;

Figure 3 is a longitudinal section of the outer conductor taken along line 3—3 showing a true view of the inner conductor; and

Figure 4 is a polar plot of field intensity against angle of elevation.

In Figure 1 is illustrated a vertically arranged antenna 10 which is a complete embodiment of this invention. It comprises an outer conductor 11 shaped as a cylindrical shell, having an array of equal-size and equally-spaced slots 12, 13, 14 and 15, arranged in a single line substantially parallel to its axis, and connected to the power source at a junction 16. A plate 17 provides a short circuiting termination at the top of the antenna between the outer conductor 11 and the inner conductor 18. The inner conductor 18 is shaped in the form of a helix and is concentric with the outer conductor 11. The inner

2

conductor segments are so arranged that a perpendicular horizontal plane surface through the middle of each slot will intersect the portion of the helix nearest to the slot. An example of this can be seen by reference to Figures 1 and 2, where the helical segment 18A is the portion nearest slot 12. As a structural aid, solid dielectrics may be used. In this embodiment a plastic plug 19 is used to keep the conductors in proper position, at the input junction 16. A single turn of the helix is accomplished between two adjacent slots.

In order to get maximum in-phase excitation at a particular wave length, the following dimensional rules are preferred:

(1) The length of the slot is made approximately equal to one-half the wave length of the desired radiation, while the length along the helix between slots is made approximately equal to the wave length.

(2) The dimensions of the helix are then determined by the following formula: $P^2 + \pi^2 D^2 = L^2$, wherein D equals the diameter of the helix, P equals the pitch and L is the length along the helix between the centers of two adjacent slots.

(3) The circumference of the helix must be less than a single wave length. Measurements are considered made as from center points of the various elements. Thickness is not critical.

In accordance with such design principles, each slot can be excited in phase because at every wave length one comes back to an in-phase point. The termination is one-quarter wave length along the helix from the last slot. In this manner, the slots are one wave length apart along the helix.

In terms of equivalent circuit theory, the sum of the conductances of each slot is equal to the in-put admittance. In effect, the antennas of this invention provide excitement of a set of slots in phase so that radiation will add perpendicularly to the line of slots.

The generalized radiation plot of Figure 4 is derived by free field measurements of an antenna constructed for use with 980 megacycles wherein the slots were approximately four inches long. As can be seen from this plot there is substantially little difference between radiation from the front of the slots or from the rear of the slots and that the beam is relatively narrow but fairly uniform. The beam height is a function of the number of slots so that a narrower beam is obtained from a greater number of slots. This invention should be distinguished from other methods of excitation of the slot, such as exciting screws, since these other methods usually result in a much more intense radiation on the slot side than on the rear of the slots.

While the invention has been described with reference to certain specific embodiments, it should be understood that the examples given are strictly illustrative and that various modifications and adaptations will be possible without departing from the spirit and scope of the invention as defined in the objects and in the appended claims.

What is claimed is:

1. A coaxial antenna comprising a plurality of slots axially-located on a tubular outer conductor and a helically-shaped inner conductor.

2. An antenna comprising a coaxial line feeding outer and inner conductors; said outer conductor of said coaxial line being tubular and slotted along a single line substantially parallel to the antenna axis; said inner conductor being shaped in the form of a helix.

3. An antenna comprising a coaxial line feeding outer and inner conductors; said outer conductor of said coaxial line being tubular and containing a plurality of slots arranged in a single line substantially parallel to

3

the antenna axis; said inner conductor being shaped in the form of a helix.

4. An antenna comprising a coaxial line feeding outer and inner conductors; said outer conductor of said coaxial line being tubular and containing a plurality of 5 equally-spaced and equal-size slots arranged in a single line substantially parallel to the antenna axis; said inner conductor being shaped in the form of a helix having a complete turn between two adjacent slots.

5. As in claim 4, wherein the length of each of said 10

4

slots is approximately equal to one-half the desired wavelength and one turn of said helix is approximately equal in its path to said desired wavelength.

References Cited in the file of this patent

UNITED STATES PATENTS

2,633,532	Sichak	Mar. 31, 1953
2,637,775	Lund	May 5, 1953
2,676,257	Hebenstreit	Apr. 20, 1954