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[56]

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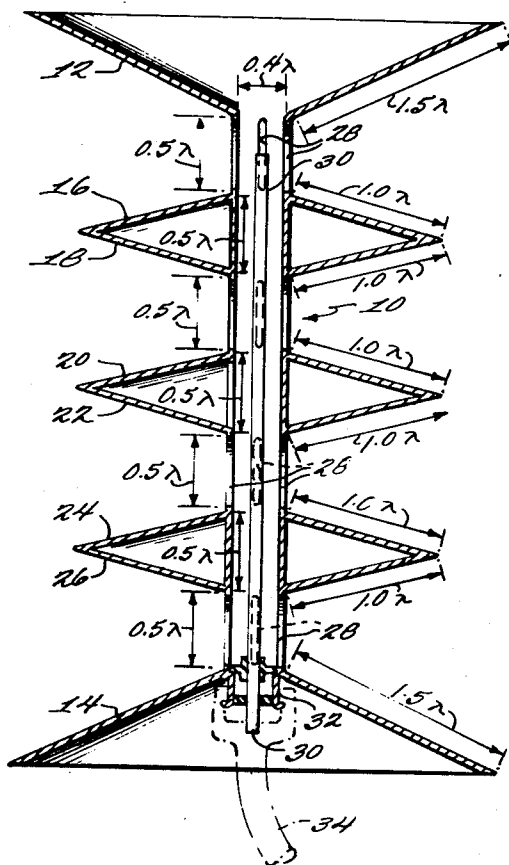
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[54] PHASED SLOT ANTENNA ARRAY WITH FRUSTOCONICAL REFLECTOR

10 Claims, No Drawings

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ABSTRACT: An antenna for omnidirectional or directional transmission. The antenna comprises a central member for supporting at least one pair of spaced frustoconical reflector elements. The support member is slotted between the reflector elements to serve as an energy radiator. Energy is supplied to the radiator by connecting adjustable probes between the slots and a central conductor within the support member.



PHASED SLOT ANTENNA ARRAY WITH FRUSTOCONICAL REFLECTOR

A shortcoming of conventional antennas for transmitting electromagnetic radiation, such as UHF television signals, is that in order to produce a concentrated radiation pattern necessary to obtain reasonable range, complex and expensive antenna constructions are required. Usually such antennas produce nulls at locations remote from the antenna but within the signal range.

Accordingly, the principal object of the present invention is to provide a simple, economical construction which achieves improved transmission range, in selected or all directions, while producing uniform radiation distribution throughout the transmission pattern.

Briefly, the invention comprises a central hollow support member to which are attached at least one pair of space frustoconical reflector elements. Slots are provided in the support member extending between the reflector elements. A central conductor is positioned within the hollow support member, this conductor carrying energy from the transmitter to the antenna. Probes connected to respective slots couple energy from the central conductor to the support member, the latter serving as an energy radiator. By adjusting the probe positions, the radiation pattern of the antenna can be controlled.

The invention will be described in further detail by reference to the accompanying drawings wherein:

FIG. 1 is a cross-sectional view of a preferred embodiment of the invention, the probes being omitted for convenience of illustration; and

FIG. 2 is an enlarged fragmented view of a portion of the arrangement shown in FIG. 1 with representative probes included.

Referring now to the drawings, the invention will be described in detail. The principal support structure of the antenna is a hollow member 10 formed of conductive material. Ideally this member has an internal diameter of approximately 0.4 the wavelength (λ) of the carrier frequency which the antenna is intended to transmit. For example, if used as a transmitting antenna for UHF channel 20, which has a wavelength of approximately 22 inches, the inside diameter of member 10 would be 8.8 inches. With an inside diameter greater than 0.4 λ , the hollow member begins to act as a waveguide, whereas below 0.4 λ , the power handling capabilities of the antenna are reduced.

Frustoconical reflecting elements 12 and 14 are connected at opposite ends of support member 10. The sides of these elements should be at least 1.0 λ in length and preferably are 1.5 λ . The angle at which the sides of elements 12 and 14 intersect member 10 is a function of the beam tilt required for the particular environment where the antenna is to be used.

Three pairs of spaced frustoconical reflecting elements are positioned along member 10 between elements 12 and 14. These comprise paired elements 16 and 18, 20 and 22, and 24 and 26. The distance between adjacent reflector elements, where they join support member 10, is 0.5 λ . The sides of elements 16, 18, 20, 22, 24 and 26 are 1.0 λ in length. Each pair of reflector elements are joined at their bases.

Vertically extending slots 28 are disposed at 90° intervals about support member 10 and extend between reflector elements 12-16, 18-20, 22-24 and 26-14. These slots are approximately 0.5 λ in length.

A central conductor 30 extends along the axis of hollow support member 10 and is fixed with respect to member 10 by conventional insulating means (not shown). The conductor 30 terminates approximately halfway between reflector elements 12 and 16. The conductor 30 may be telescoped at its end to provide adjustability to compensate for inductive and capacitive reactances thereby permitting matching to a transmission line from the transmitter. Conductor 30 serves as an inner conductor of a coaxial cable, the outer conductor being sup-

port member 10. The bottom of conductor 30 is joined through a connector 32 to the transmission line 34 extending to the transmitter (not shown).

FIG. 2 illustrates the manner by which energy is coupled from central conductor 30 to the support member 10 to be radiated thereby. More particularly, probes 36 (only an opposing pair of which are shown) are connected between each slot 28 and the central conductor. In the embodiment illustrated, one end of each probe is fixed to the support member 10 along slot 28, and the other probe end is spaced from the central conductor 30. With such an arrangement, the energy is capacitively coupled from conductor 30 to the support member 10, and the amount of energy fed to each slot 28 can be controlled by varying the probe to central conductor spacing, as by providing probes 36 with universal joints 38. By controlling the amount of energy supplied to each slot, the desired radiation pattern can be established.

The positioning of the ends of probes 36 along the slots 28 also affects the radiation pattern. Inasmuch as the slots 28 are 0.5 λ in length, this represents a possibility of varying the phase of the signal coupled by each probe 36 an amount of 180°. It is apparent, therefore, that movement of the probe one-fourth of the length of slot 28 represents a 45° phase shift of the signal. In the preferred embodiment of the invention, adjacent probes are electrically displaced by 90°. This is accomplished, for example, by connecting each of one opposing pair of probes a quarter of the slot length from the bottom of its respective slot and by joining each of the other opposing pair of probes one-fourth of the length from the top of its respective slot.

In the illustrative embodiment probes 36 capacitively couple energy from central conductor 30 to the radiator which comprises support member 10. However, energy can be directly coupled by joining opposite ends of the probe to a slot 28 and conductor 30. Also three pair of reflectors are positioned between elements 12 and 14 in the embodiment shown. However, a lesser number can be used with an attendant loss in gain of the system. More reflector pairs would increase the gain obtainable from the arrangement. The dimensions of the reflector sides, the central conductor, the reflector spacing, etc., are illustrative only, and it will be appreciated that certain variations can be made within the spirit of the invention as defined by the appended claims.

What is claimed is:

1. A transmission antenna comprising: a hollow conductive support member; a pair of spaced frustoconical reflector elements joined to said support member; a central conductor within said support member; and means electrically connecting said central conductor to the support member along individual slots in said member which extend between the reflector elements and which are disposed about the support member, said connecting means being adjustably connected to said slots in positions to effect phase displacement of the energy supplied to each slot with respect to that supplied to the remaining slots.
2. An antenna as set forth in claim 1, wherein said reflector elements are spaced at their joiner to said support member by a distance equal to one-half the wavelength of the carrier frequency to be transmitted.
3. An antenna as set forth in claim 1, wherein the side of each of said frustoconical elements is equal in length to at least the wavelength of the carrier frequency to be transmitted.
4. An antenna as set forth in claim 1, further comprising at least one additional pair of frustoconical reflector elements interposed between said first-mentioned pair of elements and spaced therefrom, each additional pair being joined at their bases.
5. An antenna as set forth in claim 4 wherein each of said reflector elements is spaced from adjacent elements at the joiner of said elements to the support member by a distance of one-half the wavelength of the carrier frequency to be transmitted.

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6. An antenna as set forth in claim 4, wherein the side of each of said frustoconical elements is equal in length to at least the wavelength of the carrier frequency to be transmitted.

7. An antenna as set forth in claim 5, wherein the side of each of said frustoconical elements is equal in length to at least the wavelength of the carrier frequency to be transmitted.

8. An antenna as set forth in claim 7, wherein the sides of the first-mentioned pair of reflector elements are equal in length to 1½ times the wavelength of the carrier frequency to

be transmitted.

9. An antenna as set forth in claim 4, wherein said slots extend between each element of said additional reflector element pair and the element positioned in spaced relationship adjacent thereto.

10. An antenna as set forth in claim 8, wherein said slots extend between each element of said additional reflector element pair and the element positioned in spaced relationship adjacent thereto.

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