

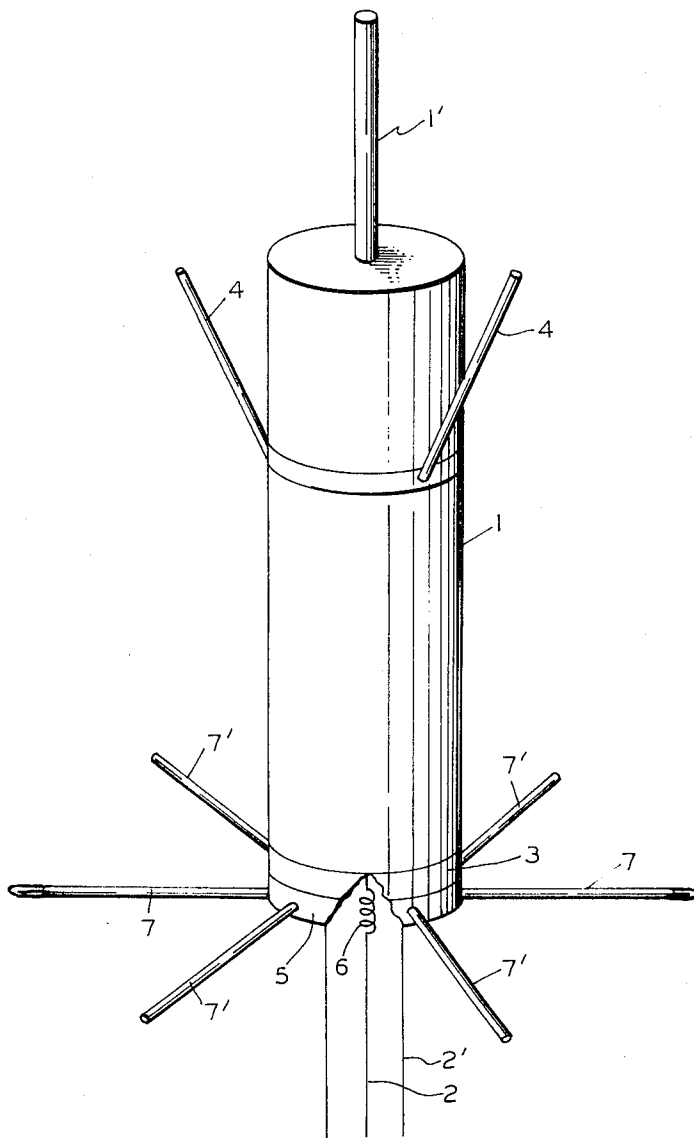
Oct. 13, 1970

V. C. SMITH, JR

3,534,378

WIDE BAND ANTENNA FOR SATELLITE NAVIGATION AND RELATED PROBLEMS

Filed Dec. 13, 1967



INVENTOR.
VALOR C. SMITH JR.

BY *Amos and Rines*

ATTORNEYS

1

3,534,378

WIDE BAND ANTENNA FOR SATELLITE NAVIGATION AND RELATED PROBLEMS

Valor C. Smith, Jr., La Mesa, Calif., assignor to Chu Associates, Inc., Littleton, Mass., a corporation of Massachusetts

Filed Dec. 13, 1967, Ser. No. 690,257

Int. Cl. H01q 9/30

U.S. Cl. 343—828

4 Claims

ABSTRACT OF THE DISCLOSURE

This disclosure deals with a novel wide band antenna that is particularly adapted for receiving satellite transmissions as for navigation purposes, the antenna being adapted through novel conductive-element configurations, to produce substantially omni-directional horizontal coverage and upwardly tilted toroidal vertical coverage substantially uniformly over the wide band.

The present invention relates to wide band antennas and is more particularly concerned with relatively lightweight antenna structures adapted simultaneously to receive frequencies over a wide frequency range substantially omni-directionally in the horizontal plane, but with an upwardly tilted toroidal vertical pattern.

In such applications as the reception of multiple-frequency satellite navigational signals, including signals in the lower frequency VHF band (such as of the order of 150 MHz.) and relatively high frequencies in the UHF region (such as 400 MHz.), it is desirable to avoid the reception of spurious reflections that are returned to the antenna as earth-reflected satellite transmissions. For this purpose, the vertical radiation pattern or coverage should be directed upward, as in the form of an upwardly tilted toroidal pattern, while the horizontal coverage should enable reception from any direction. While it is difficult to provide substantially the same pattern or coverage with a single structure over such widely different frequencies, yet, for such critical purposes as navigation and the like, it is vitally important that the radiation patterns be very closely the same irrespective of the frequencies being received.

It is to the solution of this problem that the present invention is primarily directed; it being a primary object of the invention to provide a new and improved wide band antenna of the character above described that shall discriminate against spurious ground-reflected transmissions and shall provide substantially the same radiation patterns irrespective of the frequency being received, over wide limits.

A further object is to provide a novel antenna of the character described that while particularly suited for reception purposes is also useful for transmission and is of more general applicability as well.

Other and further objectives will be explained hereinafter and are particularly pointed out in the appended claims.

In summary, however, the invention preferably embodies a cylindrical conductive structure cooperating with a ground plane member and provided with current-suppressing means of appropriate dimensions and geometric arrangement to enable the simultaneous application to the antenna of currents of widely different frequencies with substantially the same omnidirectional horizontal coverage and upwardly tilted toroidal vertical coverage. Though the words "horizontal" and "upward" are used herein, these are, of course, to be understood to be relative and illustrative only. Preferred constructional details are later set forth.

2

The invention will now be described with reference to the accompanying drawing, the single figure of which is a schematic isometric view of a preferred embodiment.

Referring to the drawing, the antenna of the invention is shown comprising a cylindrical conductive member having a first relatively large diameter section 1 that terminates in a shorter smaller-diameter section 1'. The bottom end of the member 1-1' is shown insulatingly spaced at 3 from a conductive ring-like lower extension 5 from which different-length conductors 7 and 7' radially extend in spoke-like fashion to define a common ground plane.

In accordance with the preferred embodiment of the invention, the length of the cylindrical member 1-1' corresponds substantially to the half-wavelength of one of the frequencies near the low end of the wide band of frequencies with which the antenna is simultaneously to operate. The diametric paths provided by the substantially co-planar ground conductors 7-7' correspond substantially to a similar half-wavelength, while the paths defined by the shorter conductors 7'-7' correspond substantially to the half-wavelength of one of the high frequencies near the upper end of the wide band of frequencies. It has been found that the alternate substantially equi-angular spacing of the long and short radial conductors 7, 7' provides a ground plane that acts in a substantially uniform manner for all frequencies within the band.

The cylindrical conductive member 1-1' may receive the lower frequencies of the band, being connected by the coaxial line 2-2' to act as a travelling-wave monopole with currents fed across the slot 3 between the ground plane 7-7' and the member 1-1'. In accordance with the invention, however, only the lower portion of the section 1 of the cylindrical conductor 1-1' is similarly employable for frequencies near the high end of the wide band. This result is attained by high-frequency current-suppressing and phasing conductive stubs 4, shown conically surrounding the upper portion of the section 1 at a distance from the lower end thereof corresponding substantially to a half-wavelength of a frequency near the upper end of the said wide band. The angle of the cone may be of the order of forty-five degrees, more or less. It has been found that the use of such conductors 4, in the geometry illustrated and described, will effectively render the upper portion of the cylindrical section 1 and its extension 1' ineffective insofar as the propagation of high-frequency currents is concerned, while producing no substantial impeding effect to the propagation of the low-frequency currents—and this, while generating substantially the same upwardly tilted toroidal vertical coverage or pattern at both the low and high ends of the band, and consistent with similar omni-directional horizontal coverage.

As an example, an antenna of the type described has been successfully operated for transit satellite transmissions in the frequency band from 150-400 MHz. with a cylindrical section 1 about 5¼ inches in diameter and about 29 inches in length and an extension section 1' about 11 inches in length and ¾ inch in diameter; these relative dimensions and lengths producing an excellent impedance match to a 50 ohm-coaxial line 2-2'. The current-suppressing and phasing elements 4 were disposed about 16 inches from the lower end of the member 1. The upwardly directed vertical toroidal pattern at 30° of elevation varied only about ½ decibel from the low frequency limit of 150 MHz. to the high frequency limit of 400 MHz.

In order to insure the desired travelling-wave propagation and impedance matching, appropriate choke sections or transformers, as schematically illustrated at 6,

3

have been employed. These chokes may be coaxial or lumped-circuit devices.

Further modifications will also occur to those skilled in this art and all such are considered to fall within the spirit and scope of the invention as defined in the following claims.

What is claimed is:

1. A wide band antenna for producing substantially omni-directional horizontal coverage and an upwardly tilted toroidal vertical coverage having, in combination, a cylindrical conductive means of length corresponding substantially to the half-wavelength of a frequency at the low end of the said wide band, ground plane means comprising a plurality of substantially co-planar conductors of different lengths providing paths of substantially the half-wavelengths of frequencies at both the low and high ends of the said wide band and slightly spaced from one end of the cylindrical conductive means to define a slot there-between, current-suppressing means disposed along said cylindrical conductive means a distance from said one end corresponding substantially to a half-wavelength of a frequency at said high end of the band in order to suppress the propagation of such high-frequency currents beyond said distance, and means for simultaneously feeding currents of different frequencies lying within said band between said ground plane and said one end of the cylindrical conductive means across said slot.

4

2. A wide band antenna as claimed in claim 1 and in which said ground plane conductors comprise spaced radially conductors.

3. A wide band antenna as claimed in claim 1 and in which said current-suppressing means comprises a plurality of spaced conductors defining an upwardly directed conical surface about said cylindrical conductive means.

4. A wide band antenna as claimed in claim 1 and in which said cylindrical conductive means comprises two sections of widely different-diameter cylinders, the first section being longer and of greater diameter than the second section.

References Cited

UNITED STATES PATENTS

2,267,889	12/1941	Aubert	343—826
2,724,052	11/1955	Boyer	343—830 X

HERMAN K. SAALBACH, Primary Examiner

M. NUSSBAUM, Assistant Examiner

U.S. Cl. X.R.

343—829, 848