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AIRBORNE TRANSMITTING ANTENNA

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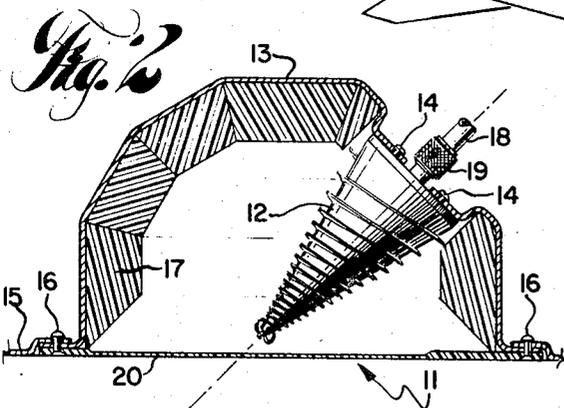
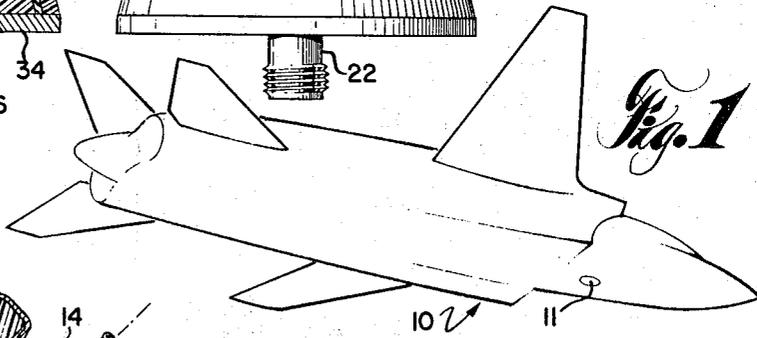
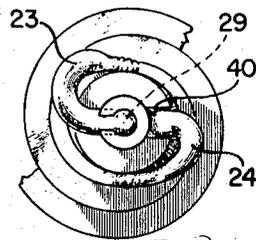
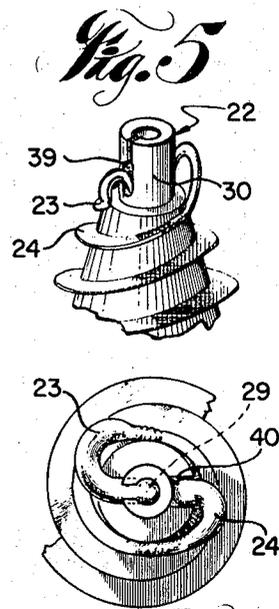
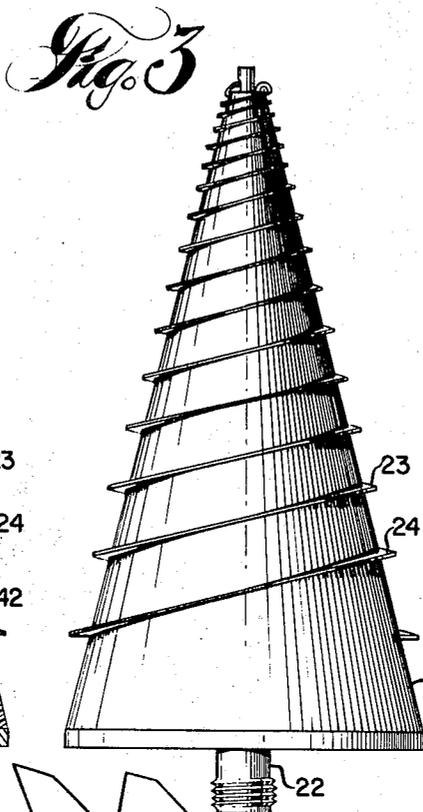
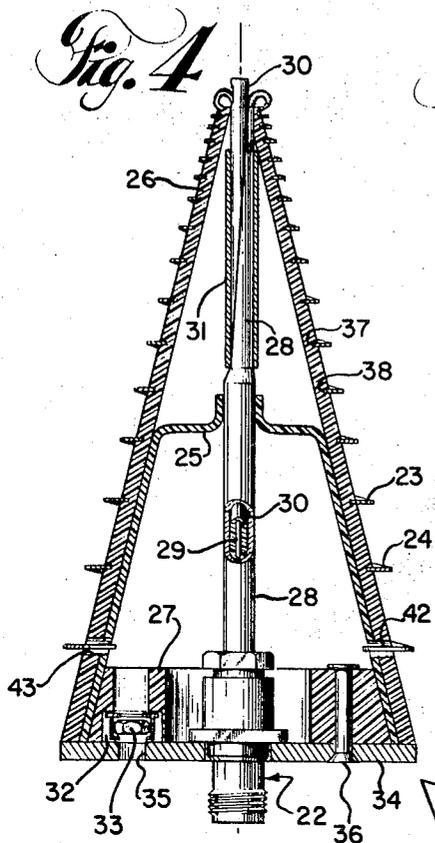
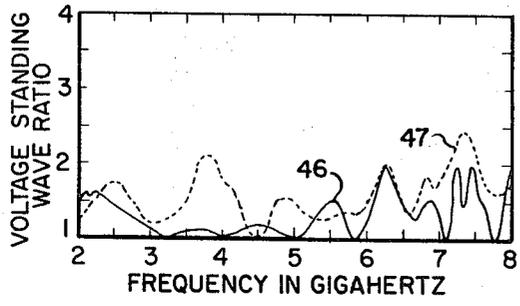
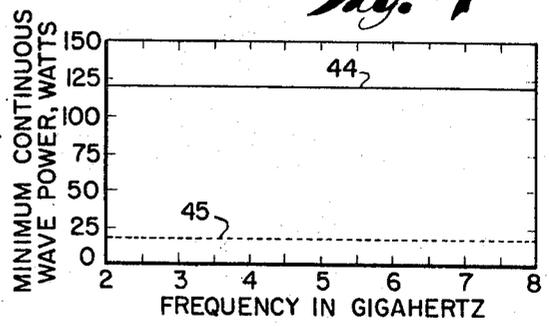


Fig. 7



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Fig. 8 

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AIRBORNE TRANSMITTING ANTENNA

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3 Claims

ABSTRACT OF THE DISCLOSURE

An airborne transmitting antenna assembly having a dielectric base portion is provided with essentially flat conductors that are edge-mounted onto the dielectric to obtain a significantly increased power-handling capability without adversely affecting other antenna performance characteristics such as radiation patterns, radiation axial ratios, and the like.

SUMMARY

The airborne transmitting antenna of this invention, in a preferred embodiment, is comprised of a conically-shaped dielectric base that supports a balun feed device and that is provided at its exterior surface with spiral conductors; such conductors are connected to the balun in electrically-conducting relation and radiate the desired radio frequency electromagnetic energy field. The spiral conductor elements are also normally fabricated of essentially flat metallic material and are mounted on the dielectric base in an edge-wound manner, as by the engagement of relatively narrow edge regions of each conductor with corresponding comparatively-shallow groove sections provided in the dielectric base exterior surface.

DRAWING DESCRIPTION

FIG. 1 is a perspective view of a type of aircraft system to which the instant invention has application;

FIG. 2 is a sectional view of an airborne transmitting antenna installation in the aircraft system of FIG. 1 and having an antenna assembly of this invention incorporated therein;

FIG. 3 is an enlarged elevational view of the antenna assembly illustrated in FIG. 2;

FIG. 4 is a sectional view of the antenna assembly of FIGS. 2 and 3;

FIG. 5 is a perspective view of the apex conductor connections shown in elevation in FIGS. 3 and 4;

FIG. 6 is a plan view of the conductor connections shown in elevation in FIGS. 3 and 4;

FIG. 7 is a graph illustrating a power-handling capability increase obtained by practicing the instant invention; and

FIG. 8 is a graph illustrating a voltage standing wave ratio characteristic obtained by practicing the instant invention.

DETAILED DESCRIPTION

FIG. 1 illustrates an aircraft system 10 having an airborne transmitting antenna installation 11 of a type to which the instant invention has application. Installation 11, in representative applications, is provided for use in connection with on-board communication equipment, electronic countermeasures equipment, or the like. As shown in FIG. 2, installation 11 includes antenna 12 of this invention, such antenna in the illustrated installation being secured to cavity-defining support 13 by fasteners 14. Support 13 is carried by airframe structure 15 and is secured in position by the fasteners designated 16. In most applications a radiation absorber material 17 is provided interiorly of support 13 to prevent energy radiated by antenna 12 into the interior of the cavity from adversely affecting the antenna performance. Antenna 12 is operatively connected

to coaxial RF energy feed 18 by coupling 19. A radiation-transparent member 20 may be secured to aircraft structure 15 by fasteners 16 also but is provided essentially for fairing and energy transmission purposes.

5 Antenna 12, in the preferred embodiment of FIGS. 3 and 4, is comprised of a conically-shaped dielectric base 21, a balun feed device 22, and spiral conductors 23 and 24. Dielectric base 21 is comprised of support member 25, cone member 26, and retainer 27 joined together by adhesive bonding or the like.

10 Balun device 22 is positioned within support 25 and is of conventional construction. In the FIG. 4 illustration, balun 22 is illustrated as having a tubular outer conductor 28, a rod-like inner conductor 29, and a dielectric insulating member 30 that separates the conductor elements. The uppermost portion of balun 22 projects through support 25 and also in-part through cone element 26. A dielectric insulating sleeve 31 is provided in surrounding relation to the uppermost portion of balun 22 in the region interior of cone member 26. Also as shown in FIG. 4, dielectric base retainer element 27 is preferably provided with recesses such as 32 that receive nut elements 33 intended for cooperation with fasteners 14. A metallic mounting plate 34 having openings 35 aligned for fasteners 14 is secured to retainer 27 by separate fasteners such as rivet 36. Conductors 23 and 24 each have a spiral configuration and are normally fabricated from essentially flat metallic material by selective chemical etching. The exact spiral configuration, such as a logarithmic spiral, is developed using known antenna configuration techniques and is not critical to the instant invention. However, in applications involving the present invention, the radial cross-section of each conductor element 23, 24 is considerably greater in width than thickness. See FIG. 4 for example.

35 Cone member 26 may be made of any of numerous different dielectric materials depending upon specific application operating temperature requirements and the like. For moderate service temperatures, cone 26 has been fabricated of conventional glass reinforced phenolic compositions. The continuous comparatively-shallow grooves 37, 38 provided in the exterior surface of cone 26 for engagement with relatively narrow edge regions of conductors 23, 24 may be developed by machining. In instances where cone 26 is made of a high-temperature material such as a ceramic, grooves 37 and 38 may be developed in the course of a molding operation. FIGS. 5 and 6 illustrate details for connecting conductor elements 23 and 24 to the conductive elements of balun device 22. Conductor 23, for instance, cooperates with over-size slot 39 in the projecting portion of the dielectric insulating member 30 and is joined to inner conductor 29 of balun 22 in electrically conducting relation. Conductor 24, on the other hand, is secured to outer conductor 28 at recess region 40 also in an electrically conducting relation. The free terminations of conductors 23 and 24 may be arranged to cooperate with openings such as 42 and 43 in the lower region of cone member 26.

70 The performance advantages that may be obtained by the practice of the instant invention in comparison to conventional antenna constructions are substantiated by the test data of FIGS. 7 and 8. Power-handling capability comparisons (curves 44 and 45 of FIG. 7) and on-axis voltage standing wave ratio comparisons (curves 46 and 47 of FIG. 8) were obtained in connection with testing a conical spiral antenna made in accordance with the instant invention and a conventional flat-wound antenna of similar conical configuration, each to voltage breakdown under substantially identical operating conditions. The improved antenna included a conical base with an apex angle of approximately 29° and with an overall on-axis

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height of approximately 4.5"; the dielectric material utilized was a glass/phenolic laminate system molded to a wall thickness of from 0.030" to 0.050" in matched metal tooling. The balun outer conductor in the improved antenna was fabricated of brass and the center conductor was silver plated copper weld wire. Both were gold plated. The balun dielectric was machined from isotatically molded, thermally stable polytetrafluoroethylene. Also in the tested antenna of this invention, the conductors 23, 24 were chemically etched using a photosensitive resist and standard chemical milling techniques to develop logarithmic spiral configurations in essentially flat copper stock approximately 0.020" thick. The reference antenna was provided with the same conical base dimensions and details except that the conductors were placed on the cone member exterior surface in a conventional flat-wound manner.

As shown by FIG. 7, curve 44, the improved antenna with edge-wound conductors in accordance with the instant invention exhibited a power-handling capability of approximately 120 watts without voltage breakdown between adjacent conductors over the frequency range of 2 to 8 GHz. in a simulated environment of 70,000' altitude and at an elevated temperature of 250° F. As shown by curve 45, the conventional flat-wound antenna operated with a power-handling capability of only approximately 20 watts under the described conditions and over the indicated frequency bandwidth. Thus, by practicing the instant invention and taking advantage of permitted increased spacing between turns, particularly in the cone apex region, and heavier conductor cross-sections, the power-handling capability of the conventional antenna may be increased approximately six-fold.

Curves 46 and 47 of FIG. 8 illustrate the voltage standing wave ratio measured along the antenna axis for the described antenna of this invention and for a comparable conventional flat-wound antenna, respectively. It is clear from FIG. 8 that no degradation of performance occurs with respect to achieving voltage standing wave ratios less than 2 over comparable operating bandwidths. Similarly, testing has established that no radiation pattern degradation occurs as a result of the improved conductor arrangement.

I claim:

1. A transmitting antenna for radiating a radio-frequency electromagnetic field having an amplitude pattern about the radiation axis of the antenna, and comprising in combination:

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- (a) feed means receiving radio-frequency electrical energy for radiation as an electromagnetic field,
 (b) dielectric base means having a substantially conical exterior surface that is geometrically defined with reference to the antenna radiation axis, and
 (c) logarithmically periodic spiral conductor means mounted on said dielectric base means and having an essentially rectangular cross-section and an inner edge surface that is narrow in comparison to conductor surface portions adjacent said inner edge surface,

said spiral conductor means being mounted on said dielectric base means with substantially only said narrow inner edge surface at and in said dielectric base means conical exterior surface and being electrically connected to said feed means to radiate radio-frequency electrical energy received therefrom as a radio-frequency electromagnetic field having an amplitude pattern about the radiation axis of the antenna.

2. The invention defined by claim 1, wherein said dielectric base means is provided in said conical exterior surface with a shallow spiral groove of width substantially equal to the width of said conductor means narrow edge surface, said conductor means being mounted on said dielectric base means in engagement with said shallow spiral groove.

3. The invention defined by claim 1, wherein said spiral conductor means adjacent surface portions include surface elements that, at conductor cross-sections, are along straight lines extending outwardly from said narrow inner edge surface, said spiral conductor means being mounted on said dielectric base means with said surface elements positioned substantially at right angles to the radiation axis of the antenna.

References Cited

UNITED STATES PATENTS

2,871,478	1/1959	Lander	343—895X
2,958,081	10/1960	Dyson	343—895
3,188,643	6/1965	Dyson et al.	343—895
3,230,540	1/1966	Keiji Endo et al.	343—895

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