Feb. 16, 1971 J. D. LEONARD 3,564,553

AIRBORNE TRANSMITTING ANTENNA

Filed Nov. 8, 1967

Fig. 4

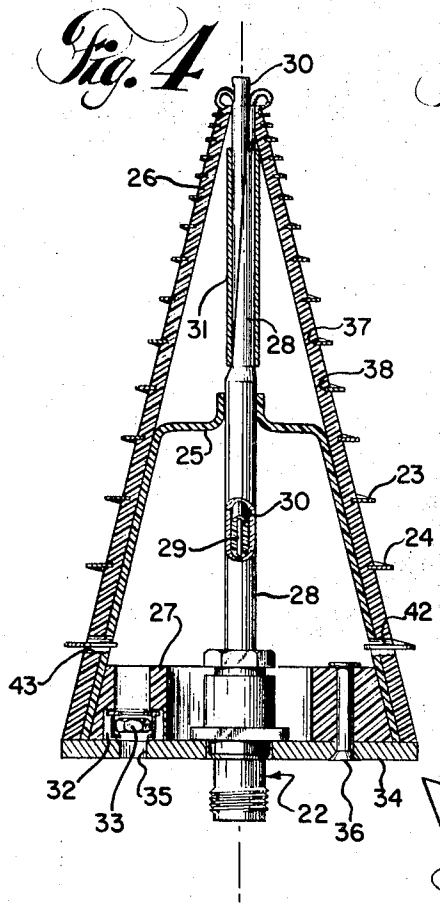


Fig. 3

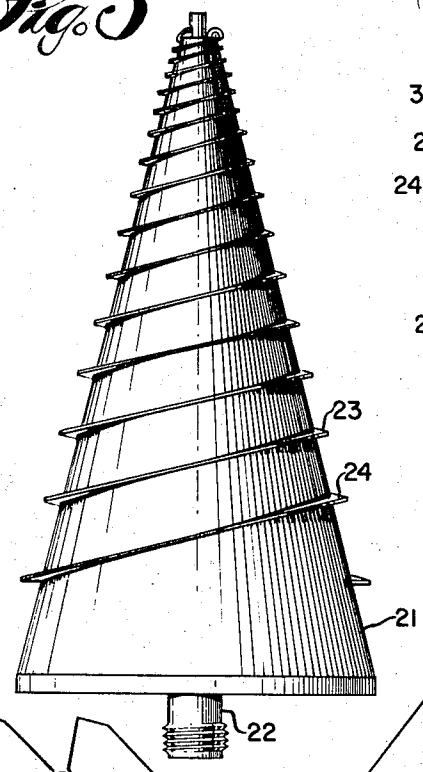
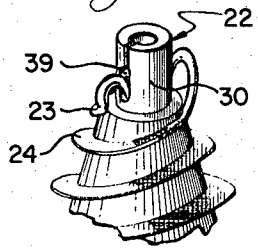


Fig. 5



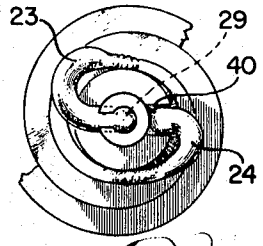


Fig. 6

Fig. 1

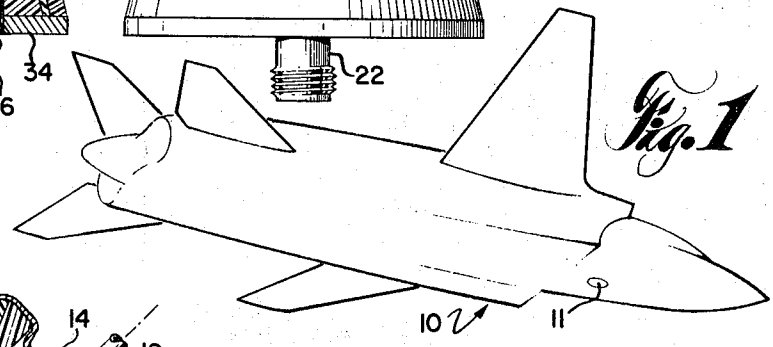


Fig. 2

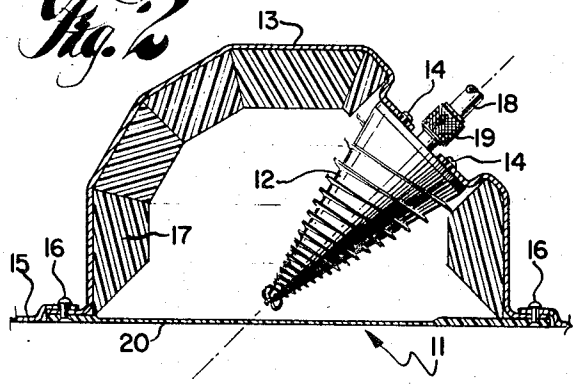
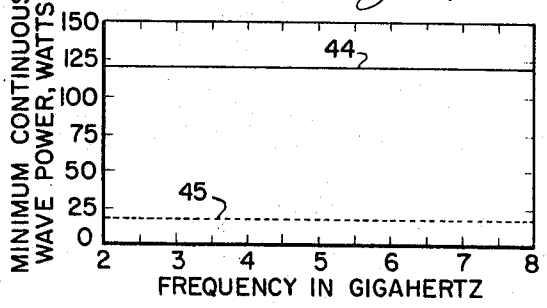


Fig. 7



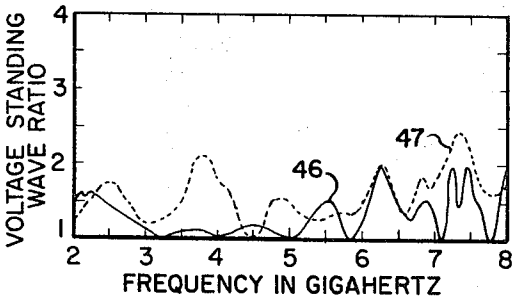


Fig. 8

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AIRBORNE TRANSMITTING ANTENNA

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U.S. Cl. 343—792.5 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.

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.

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.

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 oversize 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**.

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

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 isostatically 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:

(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.

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U.S. Cl. X.R.

343—895