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Nov. 17, 1970 C. W. MILEY 3,541,557

MULTIBAND TUNABLE NOTCH ANTENNA

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Fig. 1

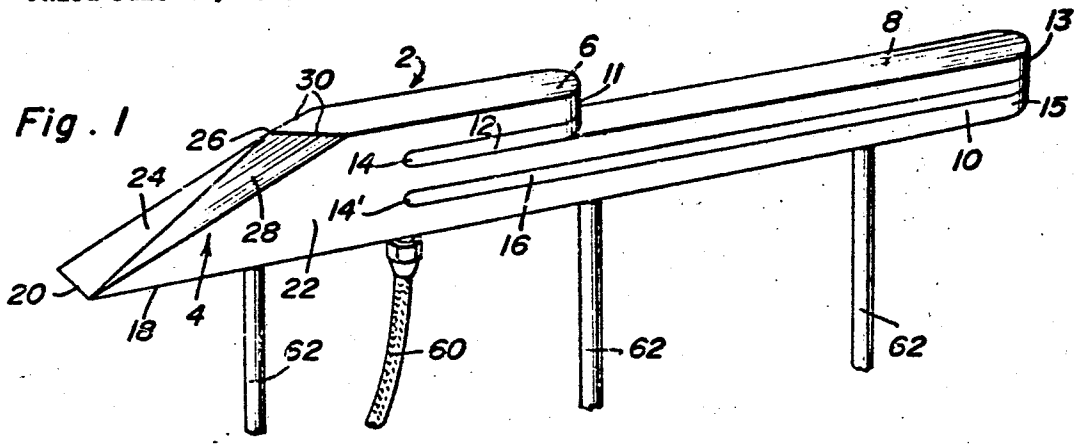


Fig. 2

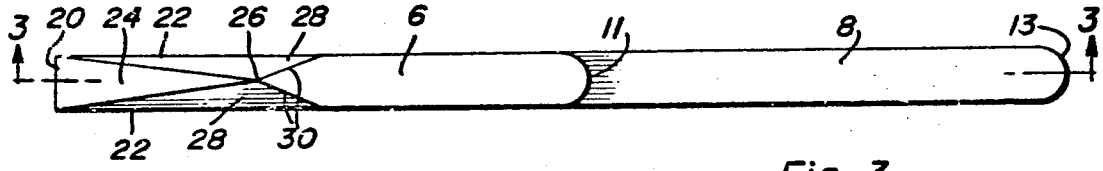


Fig. 3

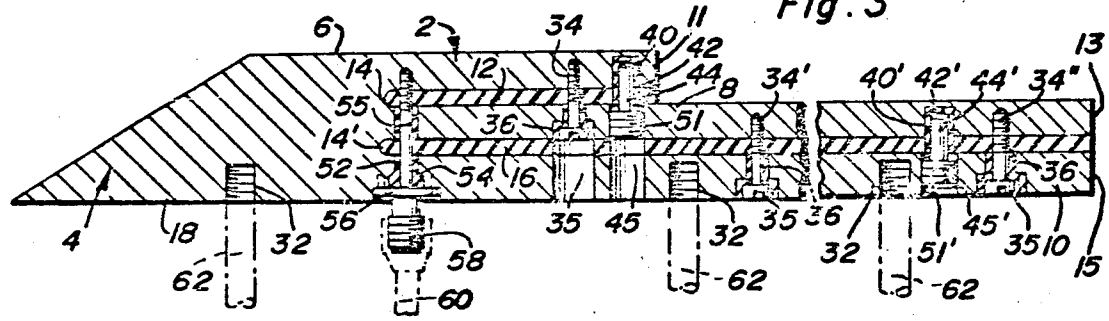
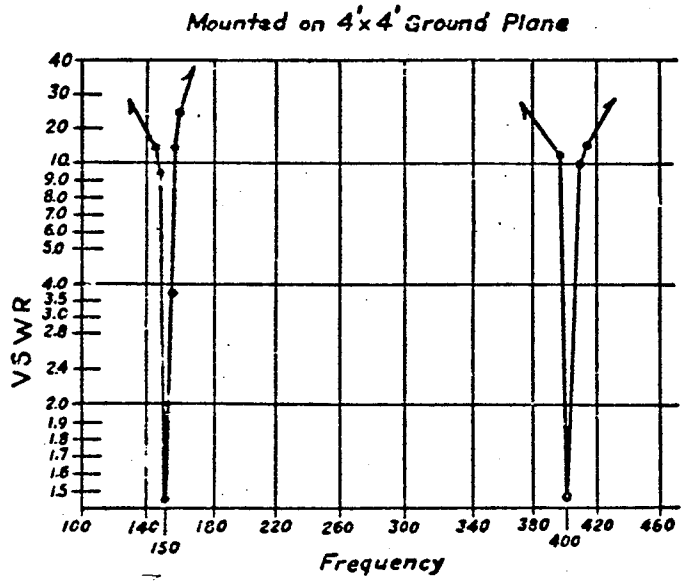


Fig. 4



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MULTIBAND TUNABLE NOTCH ANTENNA

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Fig. 5

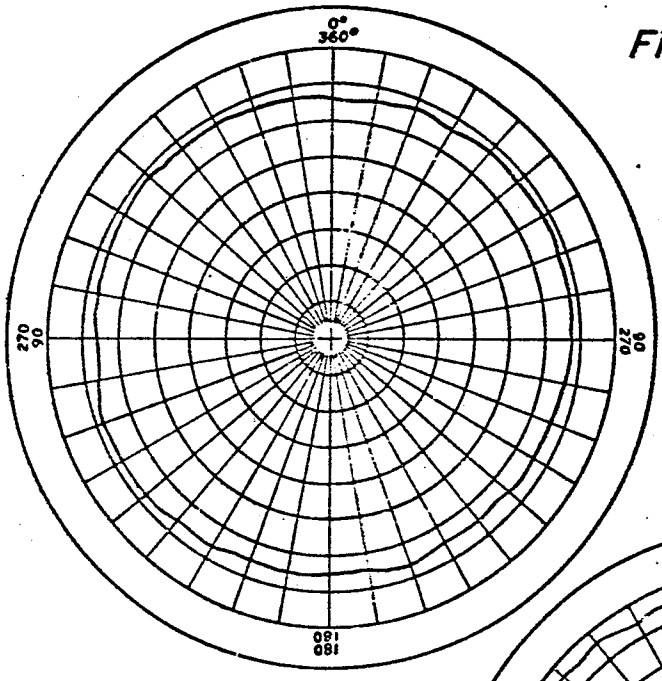


Fig. 6

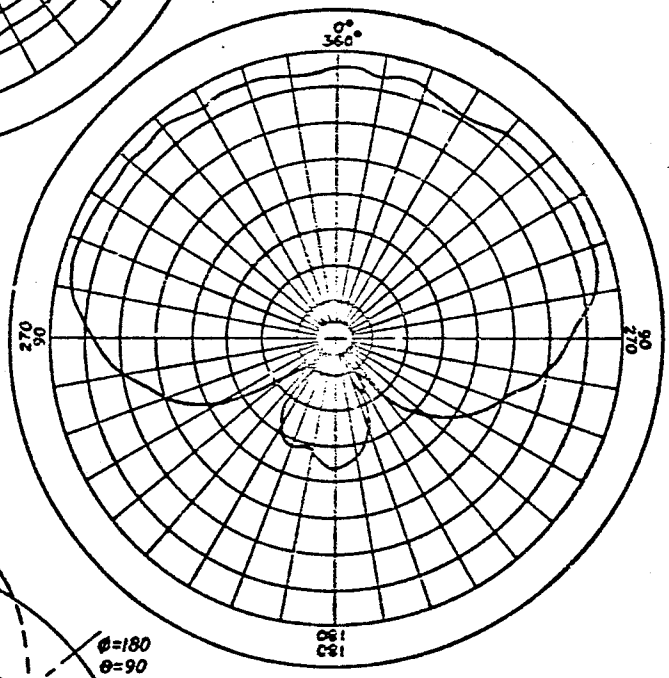
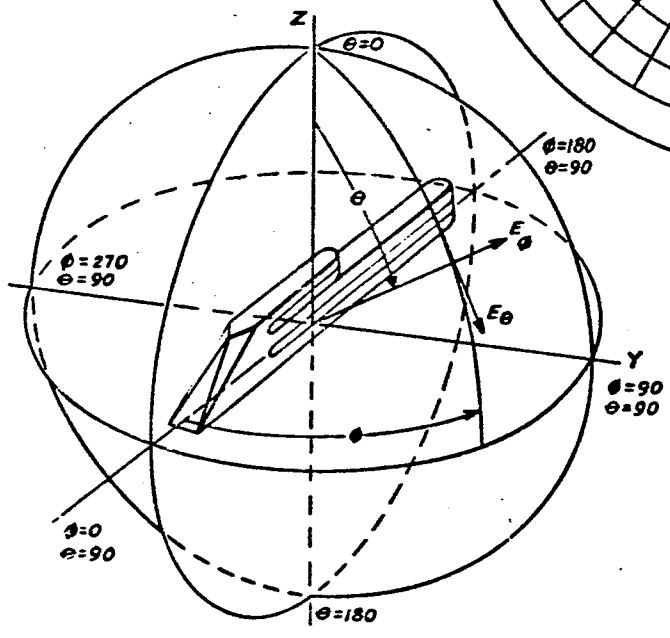


Fig. 7



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MULTIBAND TUNABLE NOTCH ANTENNA

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ABSTRACT OF THE DISCLOSURE

First and second antenna blades are retained in vertically aligned spaced relation with dielectric material interposed therebetween. A third or shortened blade is disposed in spaced overlying relationship to the aforementioned blades and separated therefrom by an interposing layer of dielectric material. Tuning slugs are capacitively connected between the first and second blades and the second and third blades, respectively. A coaxial connector is electrically connected between the first and third blades thereby providing terminal access to the antenna for signals operating at two separate frequencies, each being tunable by an associated tuning slug.

The present invention relates to a frequency tunable multiband omnidirectional dual blade antenna.

Present electronic communication system utilized in conjunction with aircraft and missile structures require multiband operation accompanied by complete top hemispherical coverage. These requirements generally necessitate a multi-array antenna system including a number of single antennas suitably attached to an aircraft or missile structure. As will be appreciated, the existence of a number of antennas associated with each craft increases the cost and time of installation and maintenance when composed with a single antenna installation. Further, prior antennas characterized by special geometrical shapes for attaining desired radiation characteristics necessitated a relatively high fabrication cost. Still further, present antennas mounted on aircraft and the like are subjected to aerodynamic stresses which have taken their toll during actual operation.

The present intended structure is characterized by a number of stacked antenna blades formed with smoothly rounded exterior end surface portions as well as straight planar surfaces that are simple and economical to fabricate. Complex geometric patterns are thereby avoided. The antenna of the present invention is instead elongated in the form to present a low silhouette resulting in a mechanically rugged and aerodynamically stable structure. These aerodynamic characteristics are enhanced by a wedge-shaped end portion rendering a streamlined low friction contour. The antenna also operates in multiple narrow band frequencies simultaneously, thereby obviating the necessity of several antenna structures and includes tuning slugs which permit the precise tuning of the antenna to two multiple narrow band frequency modes at any time after fabrication. Further, the present antenna is designed to be mounted on a ground plane and provides complete top hemispherical coverage. Accordingly, the present antenna structure satisfies a long felt need for a communication antenna with particular advantages for aircraft and missile use.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

FIG. 1 is a perspective view of the present dual blade antenna.

FIG. 2 is a top plan view of the antenna shown in FIG. 1.

FIG. 3 is a vertical cross-sectional view taken along a plane passing through section line 3—3 of FIG. 2.

FIG. 4 is a graphical representation of the Voltage Standing Wave Ratio characteristics of the antenna plotted against frequency.

FIG. 5 is a graphical representation of a field pattern taken in azimuth, and is representative of the radiation characteristics of the present antenna.

FIG. 6 is a graphical representation of a field pattern taken in elevation and representative of the radiation characteristics of the present antenna.

FIG. 7 illustrates the polar coordinate system of the field patterns shown in FIGS. 5 and 6.

Referring specifically to FIGS. 1, 2 and 3 of the drawings, reference numeral 2 generally denotes the present invention exemplified as a coaxial type antenna. Briefly, a wedge shaped body portion denoted by 4 appends to three antenna blades 6, 8 and 10, respectively. A first dielectric layer 12 is disposed between confronting surfaces of blades 6 and 8 and a second dielectric layer 16 is disposed between confronting surfaces of blades 8 and 10. It should be observed from the drawings that the outward ends 11, 13 and 15 of the aforementioned blades opposite the wedge-shaped body portion 4, are rounded and extend to flat lateral side portions. Further, the inward edges 14 and 14' of each dielectric filled space is rounded. The purpose for constructing the surfaces of the present antenna only in the form of smoothly rounded and flat surfaces is for fabrication convenience and simplicity.

As shown in FIGS. 1 and 2, the wedge-shaped body portion 4 includes a planar base portion 18 extending longitudinally across the entire length of blade 10. A straight edge 20 forms a right angle end portion of the wedge-shaped body, opposite the rounded blade ends. This straight edge also forms the base of an upwardly inclined surface 24 of isosceles triangle shape having upwardly extending arm portions converging to an apex 26 spaced from the planar lateral sides 22 of the antenna structure. The triangular surface 24 is bordered by symmetrical triangular surfaces 28 extending outwardly and downwardly to the planar lateral sides of the antenna structure. The upwardly inclined end of the wedge-shaped body portion 4 extends to the horizontally disposed antenna blade 6, which is relatively shorter than the equally long blades 8 and 10, along outwardly diverging lines of intersection 30 having apex 26 as a point of divergence.

Attention is invited to FIG. 3 in particular which illustrates the interior structure of the antenna. Three equally spaced threaded bores 32 extend upwardly from the antenna structure base 18, along the entenna base length. The threaded bores receive rods 62 for mounting the antenna to a ground plane (not shown). Three longitudinally spaced holddown bolts 34, 34' and 34" are disposed within the blades. Bolts 34' and 34" are disposed within blades 8 and 10 while bolt 34 is disposed within blades 6 and 8. Bolt 34" is larger than the other two and is positioned in the end portion of blades 8 and 10 to firmly clamp the blade ends together. As will be appreciated, each of the holddown bolts are disposed within the interposing insulating material of their respective blades. The head of each bolt is disposed within a bore 35 extending outwardly through base 18 thereby providing access to the respective bolt heads for purposes of tightening the same. An insulating sleeve 36 encircles each bolt head portion so that adjacent blades are secured in juxtaposition without the shorting thereof through an associated bolt.

A transverse bore 40 is formed through dielectric layer 12 and into blade 6. A dielectric sleeve 42 is disposed

therein and receives a tuning slug 44 having a threaded head portion extending within a second transverse bore 45 coaxially communicating with the first bore and extending upwardly from base 18 thereby permitting access and adjustment of the slug head within a threaded seat portion 51 of bore 45. This tuning slug tunes the higher frequency mode of the top antenna blade 6 by means of varying the capacity between the top blade 6 and the middle blade 8.

A second tuning slug aperture 40' for a second tuning slug 44' is formed in the middle blade 8 and extends downwardly through the dielectric layer 16 and into a second coaxially communicating bore of larger diameter 45', the second bore having a threaded seat portion 51' of bore 45' for receiving a slug head therein. A dielectric sleeve 42' identical to the aforementioned sleeve 42 is disposed within the first mentioned bore. The second tuning slug 44' tunes the lower frequency mode of the middle blade by means of varying the capacity between the middle blade and the lower blade of the antenna. In one actual embodiment, brass has successfully been used for fabricating the aforementioned tuning slugs 44 and 44' and "Teflon" has been successfully used for insulator sleeves 42 and 42'.

A bore 52 extends upwardly from base 18 through the three antenna blades and terminates within the body of the top antenna blade 6 adjacent the forward ends of the antenna blades. An insulating sleeve 54 is disposed within the bore, the sleeve forming a tubular seat for a threaded electrically conductive extension 55 of a coaxial connector 58. The connector includes an electrically conducting mounting flange 56 secured within a recess in base 18 by any suitable fasteners. The coaxial connector 58, by way of example, may be of the type manufactured by Amphenol and designated as UG58/U. Connector 58 includes an outwardly threaded terminal portion for permitting the attachment of a suitable coaxial cable 60 thereto.

In operation of the present antenna, omnidirectional top hemispherical coverage is accomplished at two selectively spaced frequencies. The antenna permits the phase center of the frequencies to be located in the same position for Doppler navigation systems. The narrow band width at each frequency mode of the antenna provides additional preselection for the communication receiver associated therewith as well as eliminating the out-of-band noise from entering the receiver. The size of each individual blade controls position of the tuning range in the frequency spectrum of that particular blade and changes in the size of these blades will shift the tuning range position in the frequency spectrum. The silhouette of the present invention is adapted to present a solid surface with no protrusions to cause hot spots in the antenna structure at high aircraft velocity. In a suitably mounted position, the base of the antenna provides electrical continuity with a ground plane. By way of example, aluminum may be utilized as a material for the antenna body. The dielectric inserts 12 and 16 positioned between confronting blade surfaces function as filler material to avoid air turbulence between the blades and also performs a vibration damping function in cooperation with the holddown bolts 34, 34' and 34".

Although the foregoing embodiment illustrates an antenna having three blades causing operation at two frequencies, it will be appreciated that multiple frequency modes in excess of two may be accomplished by simply adding more blades and associated tuning slugs to the antenna structure. The antenna will operate in narrow spaced or widely spaced multiple narrow band frequency modes simultaneously. Performance of the antenna described has been tested at 150 mc. and 400 mc., as vividly illustrated in FIG. 4 which graphically depicts the VSWR vs. frequency. In this respect, it should be appreciated that location of connector 58 along the length of the antenna determines the VSWR. Referring once again to

the operating frequencies, the antenna could just as easily operate at widely spaced frequencies such as 100 mc. and 5,000 mc. or at narrow spaced frequencies such as 100 mc. and 110 mc., or at any other desired frequencies simultaneously.

Polar radiation characteristics of the antenna are clearly shown in the charts of FIGS. 5 and 6 of the drawings with FIG. 5 specifically illustrating the substantially uniform azimuth coverage achievable by the present invention. FIG. 6 illustrates the substantially uniform top hemispherical or elevation coverage attainable with the present antenna. FIG. 7 illustrates location of the present antenna at the center of a polar coordinate system defining variables in azimuth and elevation corresponding to the charts of FIGS. 5 and 6. The angular legend in FIG. 5 represents variations in the angle ϕ while the angular legend in FIG. 6 represents variations in the angle θ.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. An antenna structure comprising a plurality of antenna blades being disposed in aligned spaced relation for defining a plurality of adjacent notches, at least one of the blades being shorter than the others, tuning means internally connected between each pair of adjacent blades for simultaneously establishing a plurality of signals at discontinuous operating frequencies, and electrical connector means interconnecting preselected blades for providing a tap-off for the signals.

2. The antenna structure set forth in claim 1 wherein the tuning means includes a capacitive tuning slug transversely positioned within each pair of adjacent blades for developing capacitance thereacross.

3. An antenna structure comprising first and second antenna blades positioned in overlying spaced relation, dielectric means disposed between said blades, a third shortened blade positioned in aligned overlying spaced relation adjacent the second blade, dielectric means interposed between said second and third blades, a first tuning slug transversely positioned within said first and second blades, dielectric means isolating said first tuning slug from said second blade, said first slug and said second blade generating capacitance between said first and second blades, a second adjustable tuning slug transversely positioned within said second and third blades, dielectric means isolating said second slug from said third blade, said second slug and said second blade generating capacitance between said third and second blades, and coaxial connector means electrically connected to at least two of the blades for providing signals at a plurality of operating frequencies.

4. The structure set forth in claim 3 together with first holddown means for securing said second and third blades in juxtaposition with interposed dielectric means, and second holddown means for securing said first and second blades in juxtaposition with associated interposed dielectric means.

5. The structure set forth in claim 3 wherein said coaxial connector means is electrically connected to said first and third blades, said connector means being disposed at a preselected point along said blades determined by a desired Votage Standing Wave Ratio.

6. The structure set forth in claim 3 together with a wedge-shaped conductor body having an inclined surface, and a transverse side, said transverse side being mounted to correspondingly aligned transverse ends of said blades.

7. The apparatus set forth in claim 6 wherein said wedge incline includes a first surface portion in the shape of an isosceles triangle extending upwardly from said base

and a pair of symmetrical triangular surface portions laterally adjacent said first surface portion, the three mentioned triangular surface portions sharing a common apex point.

References Cited

UNITED STATES PATENTS

2,990,546 6/1961 Haas ---------- 343—705

FOREIGN PATENTS

803,723 10/1958 Great Britain.

ELI LIEBERMAN, Primary Examiner

U.S. Cl. X.R.

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