March 10, 1970 W. N. CARON 3,500,421

ELECTRICALLY-SHORT CONSTANT IMPEDANCE ANTENNA

Filed Dec. 15, 1966

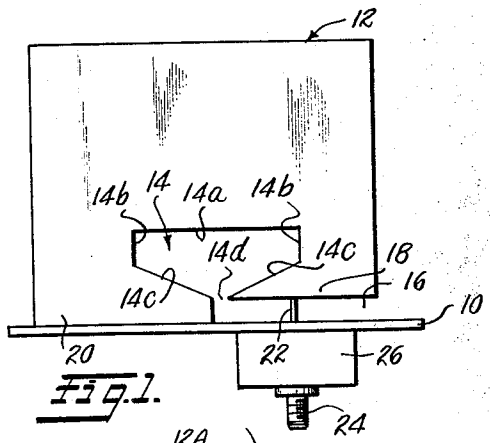


Fig. 1.

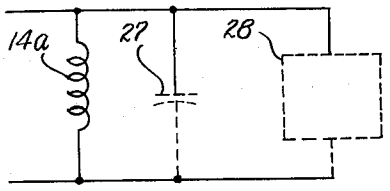


Fig. 2.

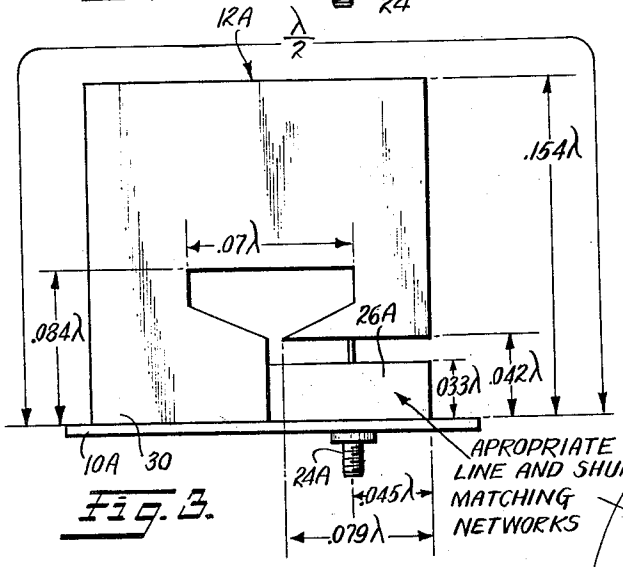


Fig. 3.

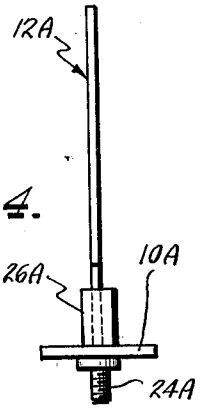


Fig. 4.

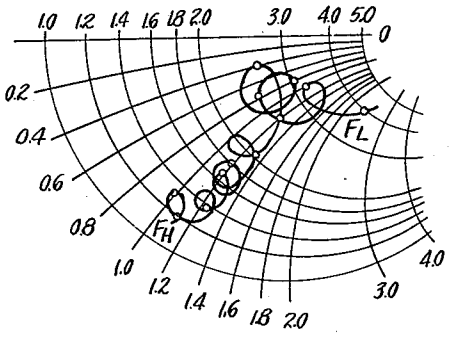


Fig. 5.

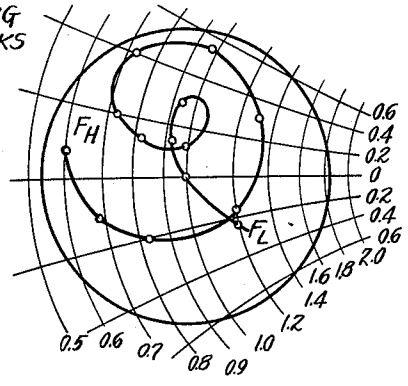


Fig. 6.

INVENTOR

WILFRED N. CARON

BY Nathaniel Ely

ATTORNEY

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ELECTRICALLY-SHORT CONSTANT IMPEDANCE ANTENNA

Wilfred N. Caron, Torrance, Calif., assignor to Dynalectron Corporation, Washington, D.C., a corporation of Delaware

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U.S. Cl. 343—767 4 Claims

ABSTRACT OF THE DISCLOSURE

An antenna of a thin conductive sheet is mounted on a base, the sheet having a rectangular short wave feed slot at the base terminating at the edge of the sheet and extending inwardly of the sheet to terminate in an enlarged opening forming a capacitative coupling to the feed slot. An exciter conductor extends across the feed slot.

BACKGROUND OF THE INVENTION

The invention relates to broadband antennas and more particularly to a folded stub broadband antenna.

Broadband folded stub antennas that have been produced heretofore, such as the scimitar antenna have resulted in excessively large structures to obtain the desired impedance band width and suffered from pattern degradation at the upper limit of their bandwidth due to their large physical size. The prior art has not disclosed the advantage and use of capacitive cut out areas in sheet antennas properly proportioned to the length of feed slot to obtain broadband characteristics with constant impedance nor the impedance of the location of the exciter in the feed slot in relation to the capacitative reactance characteristics of the slot and the communicating enlarged inductive area.

Specifically, this invention seeks to improve the types of antennas which are exemplified in U.S. Patents 2,551,664, Golper; 2,852,775; Zisler et al.; 2,944,258, Yearout et al.; 2,949,606, Dorne.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a folded stub antenna with constant impedance and stable radiation characteristics over a wide bandwidth, particularly at very high frequencies.

It is a further object of this invention to create such an antenna of very small dimensions and of short electrical height.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the invention, the following description should be read in conjunction with the drawings in which:

FIG. 1 is a side elevational view of one form of the invention.

FIG. 2 shows the substantially equivalent electrical circuit diagram for the structure of FIG. 1.

FIG. 3 shows a modified form of the invention shown in FIG. 1.

FIG. 4 is a front view of the antenna shown in FIG. 3.

FIG. 5 is a portion of a Smith chart showing thereon the impedance characteristics of an antenna built in accordance with the present invention, and

FIG. 6 is a similar portion of a chart showing the impedance characteristics of the antenna after being matched to a 50 ohm system with appropriate matching network.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now referring to the drawings in greater detail, at **10** in FIG. 1 there is indicated a rectangular base preferably a plate of metal to serve as a ground plane and supporting a radiating element **12**. This element is a thin metallic sheet mounted on the base, preferably perpendicular thereto and extending longitudinally of the base substantially medially of the width thereof. The combined height and width peripheral dimensions of the radiating element above the mounting base should be one-half wavelength at the lowest frequency of interest.

A portion of the radiating element provides an inside cavity **14** and a slotted portion **16** of high capacitance. The cavity is at the lower portion of the plate with one wall **14***a* parallel to the upper edge of the plate, two shorter walls **14***b* parallel to vertical edges of the pate and two enclosed walls **14***c* opening into a narrow throat **14***d* communicating with the slot **16**. The formation of the resulting plate is such that it forms a folded stub structure comprised of a feed section **18** and a section **20** electrically connected to the base **10** which itself may be grounded. The base **10** and the section **18** therefore may be considered to be at zero RF potential. Extending across the slotted portion **16** is a conductor **22** insulated from the base, connected to the radiating element and coupled to a transmission line as by means of coaxial coupling **24** in the bottom of a box **26** enclosing networks matching the conductor to the line as well as a shunt for the antenna, as will be described. The box may be attached to the underside of the base.

The location of the cross conductor along the length of the slot is determined by the electrical characteristics desired. Since the inside cavity is effective to present an inductive reactance to the antenna input, placing the cross conductor closer to the inside cavity **14** provides more uniform impedance characteristics but the radiation pattern then tends to become cardioid in the horizontal plane at the higher frequencies in the bandwidth selected. To preserve the desired omnidirectional radiation characteristics of the antenna, the location of the cross conductor should be close to the peripheral edge of the radiating element. However, a best compromise position between impedance and radiation characteristics is a position of the cross conductor centrally of the length of the slot.

The feed section **18** of the antenna is made to be highly capacitative. This capacitance has the effect of reducing the Q of the antenna as well as reducing and restricting changes in antenna radiation resistance. The capacitance acts as a shunt across the antenna input, as does a radiation impedance inherent in the formation of the gap. In FIG. 2 this capacitance and impedance is indicated at **27** and **28**, respectively.

Since a highly capacitative reactance is present at the antenna input, it is necessary that the antenna input be shunted with inductive reactance of the proper magnitude if the antenna is to be capable of tracking with the capacitive reactance at the input over a wide frequency range. This is accomplished by means of the provision of the cavity **14**. The cavity function is indicated as an inductance **14***a* in FIG. 2. By governing the height and width of the cavity, an inductive reactance slope can be obtained that will track with the capacitive reactance over the bandwidth employed with the antenna, thus

resulting in a stable or at least slowly varying antenna impedance.

In FIGS. 3 and 4, the box **26A** is equivalent to the box **26** in FIG. 1 and is opposite the area **30** of radiating plate **12A**. The box **26** is mounted on ground plate or base **10A**. Attachment of the line to the antenna is made via coupling **24A** extending in an insulating manner down through the base.

To understand more fully the functions of the height and width dimensions of the cavity **14**, an understanding of a shorted parallel line shunt matching section is required. A shorted parallel line shunting the transmission line of an antenna provides inductive reactance if it is less than 90 electrical degrees long. This is expressed by the equation:

$$X_L = Z \tan \theta$$

where

Z is the impedance of the parallel line and
θ is the length in electrical degrees of the parallel line.

It can be seen that by controlling the impedance Z and the electrical length θ of the shunt, that any inductive reactance slope can be obtained.

Applying this concept to the cavity **14** which consists of height and width dimensions, the height representing the length of the analogous parallel line and the width representing the spacing between conductors of the parallel line, it can be seen that with a given impedance (width) and with a given length (height), inductive reactance with a corresponding slope is shunted across the antenna input.

Through judicious selection of height and width dimensions of the cavity **14**, an inductive reactance slope closely tracking with the capacitive reactance of the antenna at the slot can be achieved. The resultant antenna impedance will vary little with frequency.

The disclosed folded stub antenna, because of its capacitative loading at the feed point, reduces the Q of the antenna while also reducing the physical size thereof in terms of the mid frequency wavelength while the broadbanding of the radiator at least in part is achieved by the use of the cavity and the formation of the slot.

Although not intended to be limitative, an antenna intended to be operated over the frequency range of from 130 to 350 mc. per sec. had the dimensions which are illustrated in FIG. 3.

Having thus described the invention, what is claimed is:

1. A folded stub broad band antenna comprising an electrically conductive base of metallic material, a radiating element secured to said base and extending substantially perpendicular to the upper surface thereof formed by a substantially rectangular metallic sheet having a base portion which is divided into two spaced sections, a first of said sections having a bottom wall electrically connected to said base and a second of said sections having a bottom wall spaced above the upper surface of said base and extending substantially parallel thereto to form a capacitive slot extending from the periphery of said metallic sheet into the interior thereof between said base and second section bottom wall, said radiating element having a cavity formed in the lower portion thereof between said first and second sections and above said capacitive slot, the walls of said first and second sections bordering said cavity being formed to provide a narrow throat between said cavity and the inner end of said capacitive slot, and a conductive feed element adapted to be connected to an input transmission line electrically connected to said second section, said conductive feed element being insulated from said base and extending across said capacitive slot intermediate the ends thereof.

2. The folded stub broad band antenna of claim **1** wherein said radiating element is of sufficient height and width so that the combined height and width peripheral dimensions thereof are at least approximately one half wavelength at the lowest frequency of operation of the antenna.

3. The folded stub broad band antenna of claim **2** wherein said cavity includes an upper wall spaced from and substantially parallel to the upper surface of said base, a pair of first side walls extending downwardly from the ends of the upper wall toward said base, said first side walls being shorter in length than said upper wall and substantially perpendicular thereto, and second side walls angled inwardly toward one another from the bottom ends of said first side walls, the lower ends of said second side walls being spaced to form said narrow throat.

4. The folded stub broad band antenna of claim **2** wherein a substantially rectangular box for coupling equipment is mounted upon the upper surface of said base beneath the bottom wall of said second section, the upper wall of said box being substantially parallel to and spaced from the bottom wall of said second section to form said capacitive slot.

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ELI LIEBERMAN, Primary Examiner

T. J. VEZEAU, Assistant Examiner

U.S. Cl. X.R.

343—708, 831