Dec. 17, 1963 A. ALFORD 3,114,913

WING TYPE DIPOLE ANTENNA WITH U-SHAPED DIRECTOR

Filed July 10, 1961 2 Sheets-Sheet 1

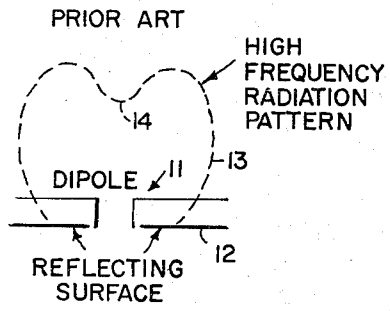


FIG. 1

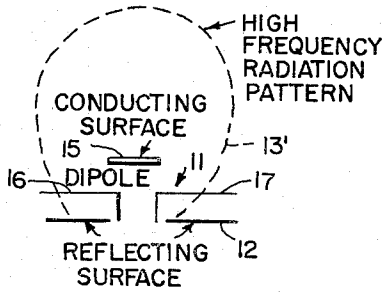


FIG. 2

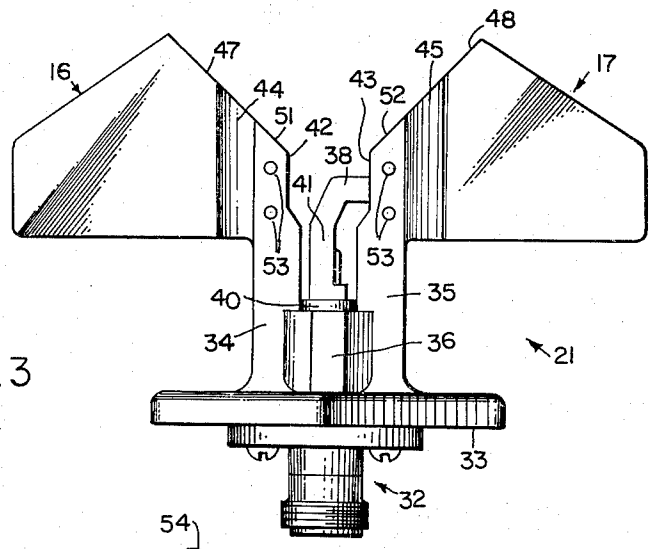


FIG. 3

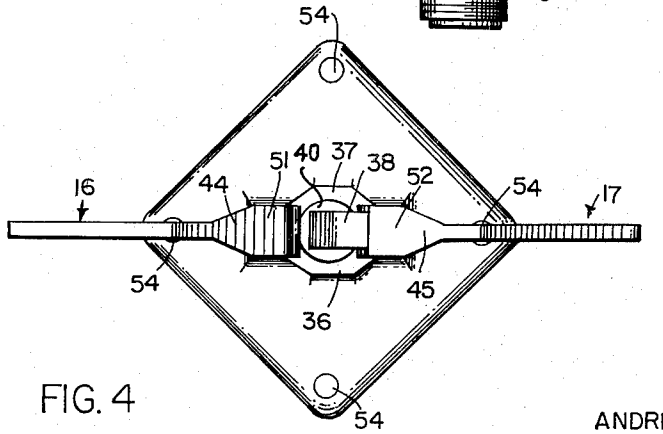


FIG. 4

INVENTOR.
ANDREW ALFORD
BY
Ezekiel Wolf, Wolf & Greenfield
ATTORNEYS

Dec. 17, 1963 A. ALFORD 3,114,913

WING TYPE DIPOLE ANTENNA WITH U-SHAPED DIRECTOR

Filed July 10, 1961 2 Sheets-Sheet 2

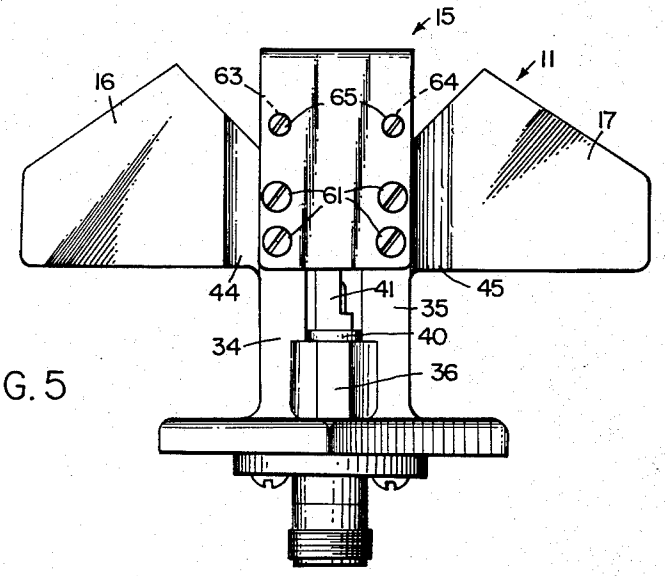


FIG. 5

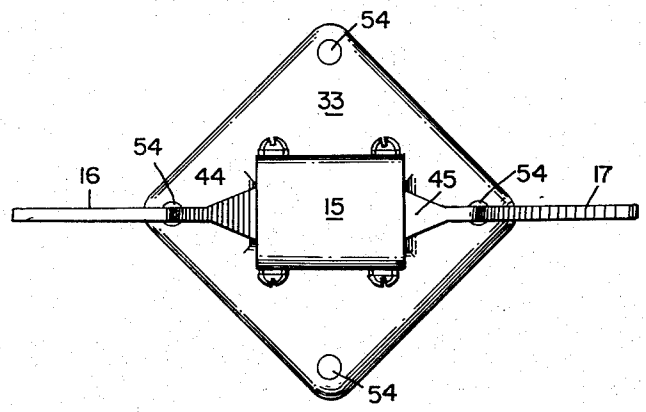


FIG. 6

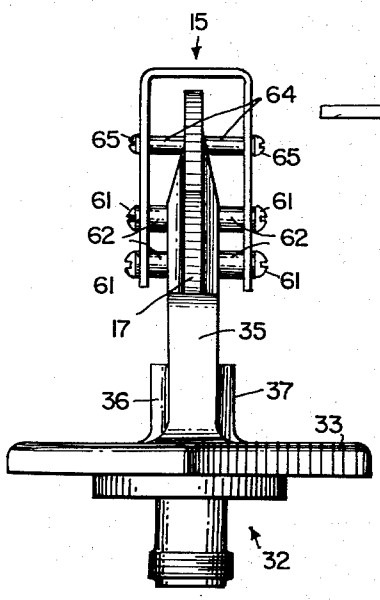


FIG. 7

INVENTOR.
ANDREW ALFORD
BY
Ezekiel Wolf, Wolf & Greenfield
ATTORNEYS

United States Patent Office 3,114,913 Patented Dec. 17, 1963

3,114,913
WING TYPE DIPOLE ANTENNA WITH U-SHAPED DIRECTOR

Andrew Alford, Winchester, Mass.
(299 Atlantic Ave., Boston, Mass.)
Filed July 10, 1961, Ser. No. 122,767
4 Claims. (Cl. 343—795)

The present invention relates in general to high frequency transduction and more particularly concerns a novel dipole radiator capable of maintaining maximum directivity along a prescribed direction over an exceptionally wide range of frequencies while introducing negligible reflections in a coaxial transmission line coupling it to external apparatus.

A preferred embodiment of the present invention represents a modification of the structure disclosed and claimed in U.S. Patent No. 2,973,517. However, the principles of this invention are generally applicable to eliminating what is termed a "saddle" radiation pattern in dipole antennas operated over an exceptionally wide bandwidth.

Accordingly, it is an important object of the present invention to provide an improved dipole radiator capable of maintaining a prescribed maximum directivity over a wide bandwidth while substantially properly terminating an interconnected coaxial transmission line so as to minimize reflections over this wide bandwidth.

It is another object of the invention to achieve the preceding object by the addition of a minimum amount of additional structure so that the increase in fabrication costs, weight and bulk are maintained relatively slight.

According to the invention, means defining a conducting surface are established across the plane of symmetry separating first and second dipole elements and insulatedly separated from the elements so that the conducting surface means coacts with each element to establish an electric field for maintaining maximum directivity along the plane of symmetry over a wide bandwidth.

Numerous other features, objects and advantages of the invention will become apparent from the following specification when read in connection with the accompanying drawing in which:

FIG. 1 is a schematic representation of a conventional dipole in front of a reflecting surface illustrating the undesired saddle high frequency radiation pattern obtained at certain frequencies when operating over an extended bandwidth;

FIG. 2 schematically represents the modification of the structure shown in FIG. 1 together with the improvement in high frequency radiation pattern obtained according to the invention;

FIGS. 3 and 4 show top and end views of a preferred exemplary embodiment according to the invention with the conducting surface removed to illustrate structural details; and

FIGS. 5–7 show top, end and side views, respectively, of the exemplary preferred embodiment according to the invention.

With reference now to the drawing and more particularly FIG. 1 thereof, there is illustrated a schematic representation of a dipole antenna **11** located before a conducting reflecting surface **12** characterized by the high frequency radiation pattern **13** with a saddle portion **14** along the plane of symmetry between the two dipole elements. This is undesirable for use in a system where maximum directivity along the plane of symmetry is required over a wide band of frequencies.

Referring to FIG. 2, there is shown a schematic representation of an improved dipole antenna radiating system capable of maintaining maximum directivity along the axis of symmetry separating the two dipole elements over an exceptionally wide bandwidth. This is accomplished by

adding the conducting surface **15**, closely adjacent to the two elements **16** and **17** comprising dipole **11** symmetrical about the axis of symmetry separating the elements **16** and **17**. The result of adding element **15** is to produce the high frequency radiation pattern **13'** and thereby eliminate the saddle portion **14** of FIG. 1. It is believed that conducting surface **15** coacts with elements **16** and **17** to form a pair of energy gaps which radiate at higher frequencies so as to fill in the saddle portion **14**. At lower frequencies the element **15** seems to have negligible effect on the satisfactory radiation characteristics of the elements **16** and **17** alone. The length of elements **16** and **17** is preferably of the order of a quarter wavelength at the center frequency of the operating band while the length of conducting surface **15** along the direction of the length of elements **16** and **17** is preferably less than the length of either of elements **16** and **17** and is separated from each of these elements by less than the length of either.

With reference now to FIGS. 3 and 4, there are shown top and end views, respectively, of a dipole radiator comprising an exemplary embodiment of the best mode now contemplated for practicing the invention with the conducting surface **15** removed so that structural details may be illustrated. The dimensions in the drawing as filed are true scale drawings of the Alford Manufacturing Company type 1063 broad band microwave dipole which maintains the desired directivity and low VSWR over a frequency range from 1,000 to 2,200 megacycles. The length of each dipole radiating element is 1⅞ inches, corresponding to a quarter wavelength at 1,575 megacycles, a frequency just above the geometric mean frequency of the band and just below the arithmetic mean.

The structure illustrated in FIGS. 3 and 4 comprises primarily an aluminum casting **21** with a coaxial terminal pair **32** screwed to the base **33** of the casting. A left leg **34** and right leg **35** extend from base **33** for supporting dipole elements **16** and **17**, respectively. Legs **34** and **35** are joined by the faceted sections **36** and **37** and coact therewith to form the outside conductor of an extension of the coaxial transmission line attached to coaxial terminal pair **32**. The inner conductor of this coaxial transmission line extension is connected to dipole element **17** by a segment **38**. Observe that segment **38** includes a portion **41** generally parallel to both legs **34** and **35** but closer to leg **34** than to leg **35**. Segment **38** coacts with legs **34** and **35** to form a balun for converting an unbalanced signal between the inner and outer conductors of the coaxial transmission line extension into a balanced signal developed across the top inside surfaces **42** and **43** of legs **34** and **35**, respectively, adjacent to dipole elements **16** and **17**, respectively. An insulator **40** is seated within faceted sections **36** and **37** for insulatedly supporting the inner conductor therein. It has been discovered that positioning straight portion **41** of segment **38** asymmetrically as shown improves the properties of the balun in matching the impedance of the radiating structure to that of the coaxial transmission line over the desired wide bandwidth.

The inside portions **44** and **45** of radiating elements **16** and **17**, respectively, taper gradually to the increased thickness of legs **34** and **35**. Elements **16** and **17** are trapezoidal. Their inwardly tapering sides **47** and **48**, respectively, smoothly join the tapered end surfaces **51** and **52**, respectively, of legs **34** and **35**, respectively. Legs **34** and **35** are tapped at a number of locations, such as **53** for accommodating screws used to support conducting surface **15**. Base **33** is formed with a number of openings **54** for accommodating bolts securing it to the reflecting surface **12**. The reflecting surface **12**, not illustrated in detail here, may be the well-known tri-plane

reflector. The distance between the feedpoint where element 38 is connected to leg 35 and the portion of the reflecting surface essentially coplanar with the junction between coaxial terminal pair 32 and base 33 is of the order of a quarter wavelength at the same frequency as the elements 16 and 17.

Referring to FIGS. 5–7, there are shown top, end and side views, respectively of the exemplary embodiment of the invention with the conducting surface 15 positioned according to the invention and supported by legs 34 and 35. Conducting surface 15 is generally U-shaped with Teflon screws 61 and Teflon annular spacers 62 securing conducting surface 15 in insulatedly spaced relationship with respect to elements 16 and 17 symmetrical about the plane of symmetry included by elements 16 and 17 and the axis of symmetry separating these elements. A pair of conducting rods 63 and 64 are secured to conducting surface 15 by screws 65 as shown for adding rigidity to the U-shaped surface and functioning electrically to help maintain the impedance match over the desired bandwidth.

There has been described a novel dipole antenna structure capable of maintaining a single major lobe directivity aligned in a prescribed direction over an exceptionally wide bandwidth while maintaining the VSWR in a connecting transmission line relatively low. It is evident that those skilled in the art may now make numerous modifications of and departures from the specific exemplary embodiment described herein, for example, by using different types of dipoles and conducting surfaces of different forms, without departing from the inventive concepts. Consequently, the invention is to be construed as limited only by the spirit and scope of the appended claims.

What is claimed is:

1. High frequency radiating apparatus characterized by a radiation pattern having a maximum along a prescribed direction over a frequency range of the order of 2:1 comprising, first and second like generally planar dipole radiating elements, each having a length corresponding substantially to a quarter wavelength at a frequency between the arithmetic and geometric means of said frequency range and symmetrical about a first plane of symmetry generally perpendicular to a second plane of symmetry included by said elements, first and second legs generally parallel to and symmetrical about said first plane inside of and connected to respective ones of said first and second radiating elements, said elements and said legs defining a generally Y-shaped gap symmetrical about said first plane, a generally U-shaped conducting surface covering the central portion of said Y-shaped gap insulatedly separated from said elements and said legs and symmetrical about said first and second planes, and a reflecting surface separated from said radiating elements by said legs and spaced from said elements substantially by said quarter wavelength.

2. High frequency radiating apparatus in accordance with claim 1 and further comprising first and second conducting rods connected from one leg of said U-shaped conducting surface to the other across said Y-shaped gap symmetrical about said first and second planes.

3. High frequency radiating apparatus in accordance with claim 1 and further comprising, a coaxial transmission line section having an inner conductor and an outer conductor, and a balun comprising said legs for transducing an unbalanced signal across said inner and outer conductors with a balanced signal between said elements.

4. High frequency apparatus in accordance with claim 3 wherein said balun further comprises, a conducting segment having a first portion generally parallel to said legs and a second portion connected to one of said elements, said first portion being closer to the other of said elements than to said one element.

References Cited in the file of this patent

UNITED STATES PATENTS

2,485,138	Carter	Oct. 18, 1949
2,726,390	Weiss	Dec. 6, 1955
2,886,813	Hings	May 12, 1959
2,973,517	Watts	Feb. 28, 1961