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BENT PLATE ANTENNA

STATEMENT OF GOVERNMENT INTEREST

[0001] The invention described herein was made in the performance of official duties by employees of the U.S. Department of the Navy and may be manufactured, used, or licensed by or for the Government of the United States for any governmental purpose without payment of any royalties thereon.

CROSS REFERENCE TO OTHER PATENT APPLICATIONS

[0002] None.

BACKGROUND OF THE INVENTION

1) Field of the Invention

[0003] The present invention is directed to antennas and more particularly to an antenna having bent plates that enable operation of the antenna over a wide frequency bandwidth.

2) Description of the Prior Art

[0004] An antenna may be used for transmission of a signal, in which radio-frequency electrical energy from a transmitter is converted to electromagnetic energy and radiates into the surrounding environment for reception of a signal. Electromagnetic energy impinging on the antenna converts into radio-frequency electrical energy and is fed to a receiver. The frequency bandwidth depends on the size and design for a particular frequency while reception and transmission signal strength depends on the orientation of the antenna with respect to a signal path.

[0005] Antennas that operate efficiently over a wide frequency bandwidth and have a beam pattern to permit reception and transmission of signals over a substantial portion of the space above are highly desirable.

SUMMARY OF THE INVENTION

[0006] The bent plate antenna of the present invention includes a surface mounting base having a horizontal or flat portion and a vertical portion. The vertical portion is perpendicular to the flat portion to define a vertical plane. A planar face of a base piece attaches to the vertical plane with the base plate integral to a first arm and a second arm collinear to the base plate.

[0007] The first arm includes a first section extending from the base piece in the vertical plane. The first section has a proximal end connected to the base piece and a distal end. The first arm also includes a second section having a proximal end connected to the distal end of the first section. The second section extends orthogonal from the distal end of the first section in the vertical plane. The first arm also includes a third section extending linearly from a distal end of the second section. The third section is bent at an angle out of the vertical plane.

[0008] The second arm includes a first section extending from the base piece in the vertical plane. The first section has a proximal end connected to the base piece and a distal end. The second arm also includes a second section having a proximal end connected to the distal end of the first section and extends angularly from the distal end of the first section in the vertical plane. The second arm further includes a third section extending linearly from the distal end of the second piece. The third section is bent at an angle out of the vertical plane.

[0009] A connector port is fastened to the mounting base. A stem connects the base piece to the connector port.

[0010] The antenna of the present invention operates over a nominal bandwidth of plus or minus twenty-three percent from a center design-frequency and is not impacted by de-tuning issues. The antenna is shaped and sized to radiate or receive signals over a large hemispherical portion of space. The antenna maintains the hemispherical beam pattern characteristic over a wide band of frequencies with an electrical match to a 50-ohm receiver or transmitter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Other objects, features and advantages of the present invention will become apparent upon reference to the following description of the preferred embodiments and to the drawings, wherein corresponding reference characters indicate corresponding parts throughout the several views of the drawings and wherein:

[0012] **FIG. 1** is a perspective view of an antenna of the present invention;

[0013] **FIG. 2** is a perspective view of a bent plate used in the antenna;

[0014] **FIG. 3** is a front view of the bent plate with dimensions; and

[0015] **FIG. 4** is an enlarged view of a portion of the antenna with dimensions.

DETAILED DESCRIPTION OF THE INVENTION

[0016] Referring to the drawings, **FIG. 1** depicts an antenna **100.** The antenna **100** includes a metal sheet **102** bent and shaped as described in further detail below. The antenna **100** has a surface mounting base **104** with a flat portion **106** fastened to a ground plane **200.** The ground plane **200** is usually a metal ground plane, but may be water, such as seawater, or another surface.

[0017] The mounting base **104** also has a vertical portion **110.** The vertical portion **110** defines a vertical plane perpendicular to the ground plane **200.** The vertical portion **110** is divided into a first section **112** and a second section **114.** Each of the sections **112, 114** is in the same vertical plane. A gap is located between the sections **112, 114.** The vertical portion **110** fastens to the metal sheet **102.**

[0018] An insulating support **118** is provided between the metal sheet **102** and the vertical portion **110.** The insulating support **118** may be made of a polymer (e.g., Delrin). A connector port **120** is fastened to the mounting base **104** between the first section **112** and the second section **114.** Typically, the connector port **120** is a coaxial connector with an insulated center pin connected to a signal receiver, as would be known by one of ordinary skill in the art. A stem **122** connects the metal sheet **102** to the connector port **120.** The stem **122** may be made of metal or other conductive material.

[0019] **FIG. 2** depicts the formed metal sheet **102** used in the antenna **100** of the present invention. The metal sheet **102** includes a base piece **124,** a first arm **126,** and a second arm **128.** The base piece **124** is located in the vertical plane defined by the vertical portion **110** of the mounting base **104,** shown in **FIG. 1.** The first arm **126** includes a first section **130** extending perpendicular from the base piece **124** in the vertical plane. The first section **130** has a proximal end **132** connected to the base piece **124** and a distal end **134.**

[0020] The first arm **126** further includes a second section **136** having a proximal end **138** connected to the distal end **134** of the first section **130** and a distal end **140.** The second section **136** extends orthogonal from the distal end **134** of the first section **130** in the same vertical plane as the first section **130** and the base piece **124.** The first arm **126** further includes a third section **142** extending linearly from the distal end **140** of the second section **136.** The third section **142** is bent at an angle out of the vertical plane.

[0021] The second arm **128** includes a first section **144** extending perpendicular from the base piece **124** in the vertical plane. The first section **144** has a proximal end **146** connected to the base piece **124** and a distal end **148.** The second arm **128** also includes a second section **150** having a proximal end **152** connected to the distal end **148** of the first section **144** and a distal end **154.** The second section **150** extends at an angle from the distal end **148** of the first section **144** in the same vertical plane as the first section **144** and the base piece **124.** The second arm **128** further includes a third section **156** extending linearly from the distal end **154** of the second section **150.** The third section **156** is bent at an angle out of the vertical plane. As shown in **FIG. 2**, the first arm **126** and the second arm **128** are bent at the same angle in opposite directions out of the vertical plane.

[0022] Referring to **FIG. 3** and **FIG. 4** the physical dimensions of the antenna **100** are determined at a desired center design frequency f_o (in Hertz, Hz), followed by calculation of the corresponding wavelength λ_o by Equation **(1)**:

$$\lambda_o = \frac{v_o}{f_o} \qquad \textbf{(1)}$$

where v_o is the speed of light (≈ 3×10^8 meters/sec).

[0023] Once the wavelength λ_o is calculated, dimensions for the various sections of the antenna **100** are determined such that the realized power gain of the antenna **100** is at maximum. **Table 1** lists empirically derived nominal antenna dimensions for maximum gain at the center design frequency.

Table 1

Symbol	Description	Dimension
L1	third section **142** of first arm **126**	0.22 λ_o
L2	second section **136** of first arm **126**	0.05 λ_o
L3	first section **130** of first arm **126**	0.14 λ_o
L4	base piece **124**	0.19 λ_o
L5	first section **144** of second arm **128**	0.17 λ_o
L6	second section **150** of second arm **128**	0.08 λ_o
L7	third section **156** of second arm **128**	0.22 λ_o
W	width of metal sheet **102**	0.07 λ_o
T	thickness of metal sheet **102**	0.005 λ_o
α	bend angle(s)	45°
S	spacing between metal sheet **102** and vertical portion **110** of mounting base **104**	0.01 λ_o
G	gap	0.05 λ_o

H	vertical portion **110** of mounting base **104**	0.05 λ_o
Y	section **112, 114** of vertical portion **110** of mounting base **104**	0.05 λ_o

[0024] The antenna dimensions listed in **Table 1** yield peak power gain at the center of the selected design frequency. The gain falls away from a peak value at rates dependent on the electrical conductivity and size of the ground plane **200.** For a finite-size metal ground plane, the normalized gain reaches one-half (or 3-dB down) of a maximum value at a frequency deviation of about 23.5% from the center design frequency, while for a seawater ground plane; the deviation is somewhat asymmetrical, being approximately 24% below and approximately 29% above the center design frequency.

[0025] The radiation beam patterns of the antenna are generated by the vector surface current distribution on the first arm **126** and the second arm **128** as well as the ground plane **200.** The magnitude and phase of the current along the first arm **126** and the second arm **128** are controlled by the electromagnetic coupling from arm-to-arm and from arm-to-ground, as set by the spatial arrangement. For a given ground plane size, the pattern shape is stable with variation in frequency and with satisfactory levels (greater than 0 dBi).

[0026] The antenna beam pattern when mounted on a ground plane of finite-extent will change from that of the infinite-extent case because a fraction of the vector surface currents induced on the ground plane (as generated by the antenna) propagate toward the edges with an amplitude that varies inversely with the electrical size of the ground plane. An abrupt discontinuity is presented by these edges to those propagating currents, which in turn generate a secondary radiative source, sometimes referred to as a *Huygens* source, having an amplitude and phase that depends on the ground plane shape and its electrical size.

[0027] The antenna **100** of the present invention is useful in maritime satellite communications. The pattern of the antenna over seawater is similar to the infinitely large metal ground plane case, except near the horizon (90° and 270°) where the pattern tucks inward due to the interaction between the direct ray from the antenna and the reflected ray from the sea. As the elevation angle approaches 90° (and 270°); the vector sum of the direct and reflected rays becomes smaller as each component becomes equal in magnitude but opposite in phase. In the shadow region, the fields are nonexistent.

[0028] It will be understood that many additional changes in the details, materials, steps and arrangement of parts, which have been herein described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art within the principle and scope of the invention as expressed in the appended claims.

BENT PLATE ANTENNA

ABSTRACT OF THE DISCLOSURE

An antenna is provided which includes a base piece, a first arm, and a second arm. The first arm includes a first section extending vertically from the base piece. The first arm also includes a second section connected to the first section. The second section vertically extends orthogonal from the first section. The first arm further includes a third section extending linearly from the second section. The third section is bent at an angle out of the vertical plane. The second arm includes a first section vertically extending from the base piece. The second arm also includes a second section connected to the first section. The second section angularly extends from the first section in the vertical plane. The second arm further includes a third section extending linearly from the second section. The third section is bent at an angle out of the vertical plane.

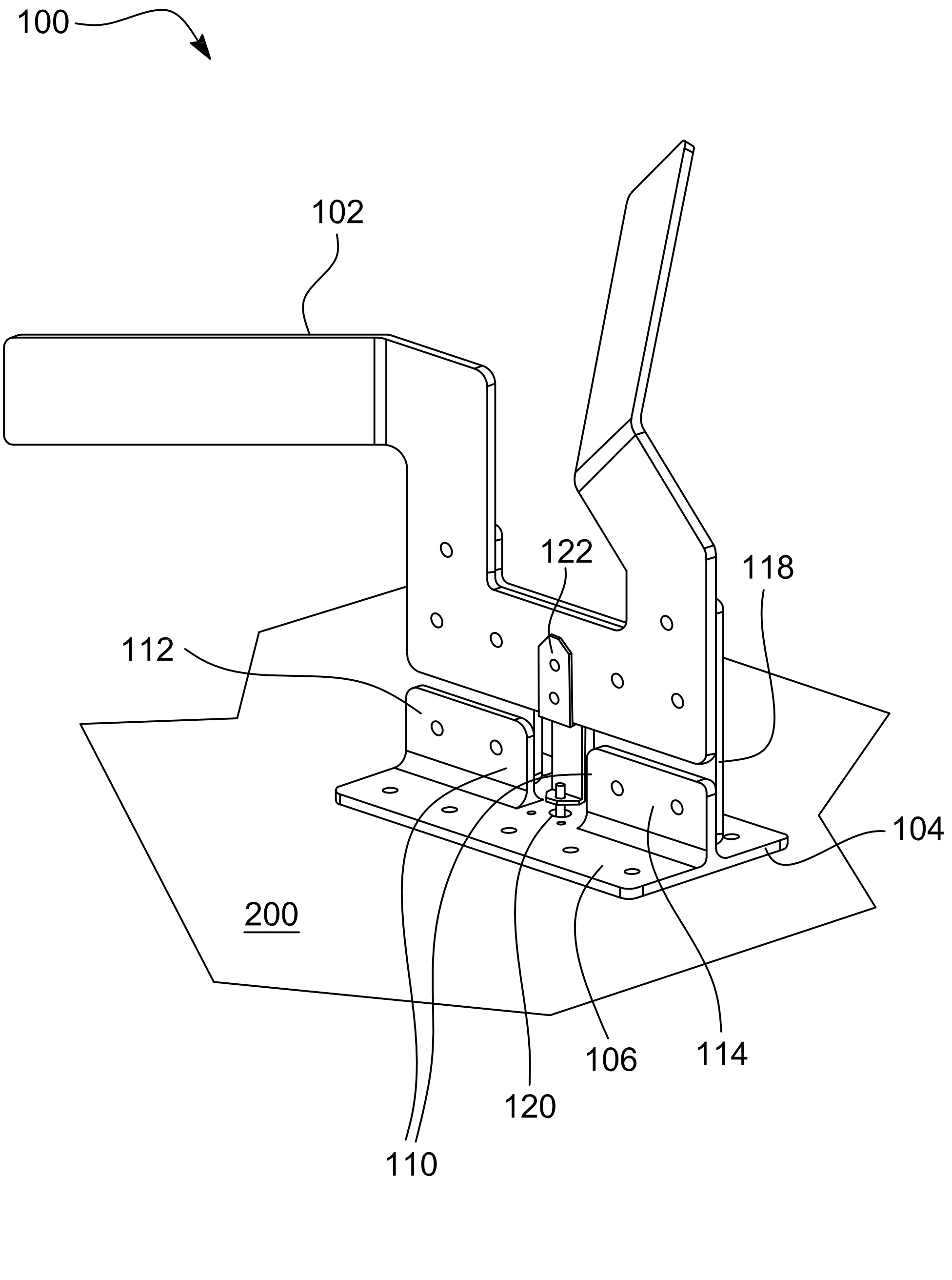

FIG. 1

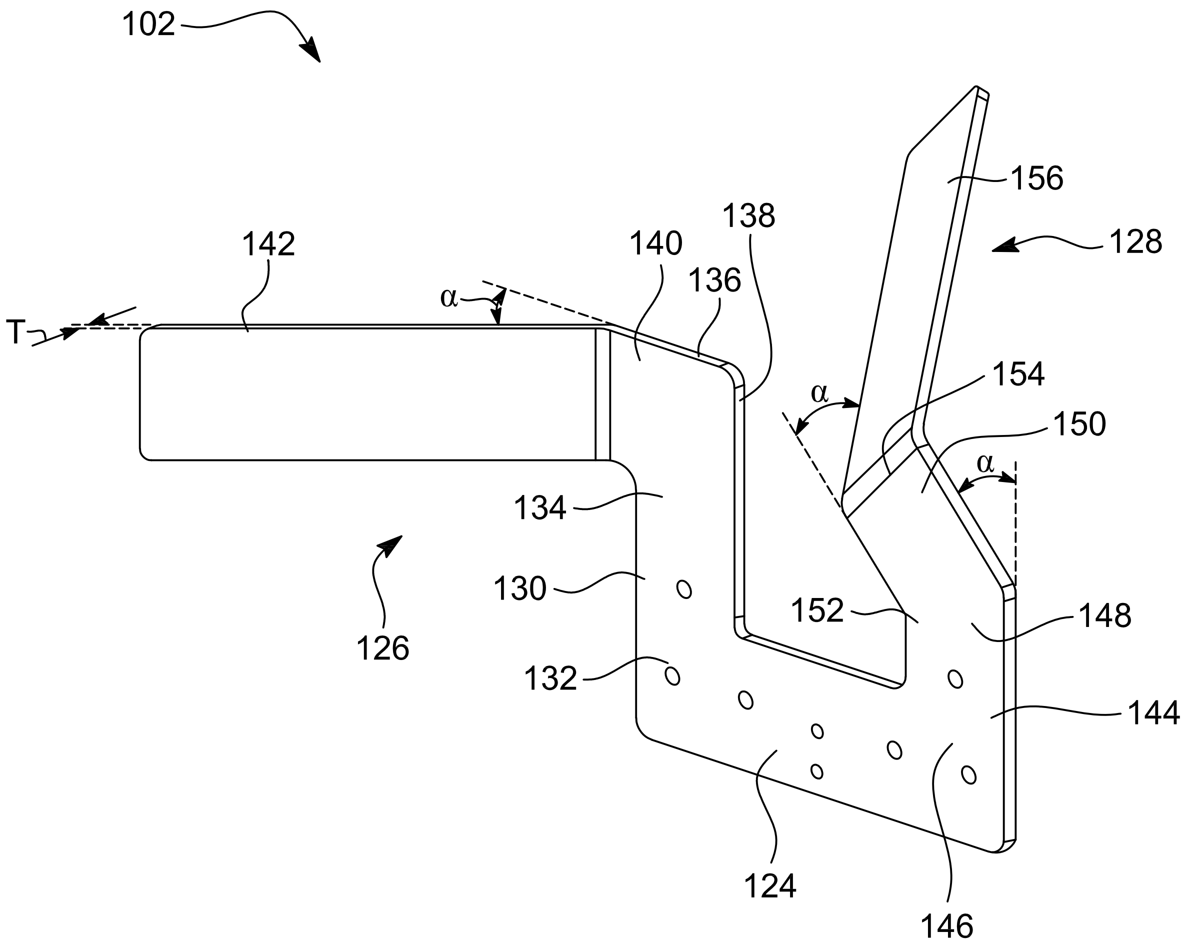
102
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FIG. 2

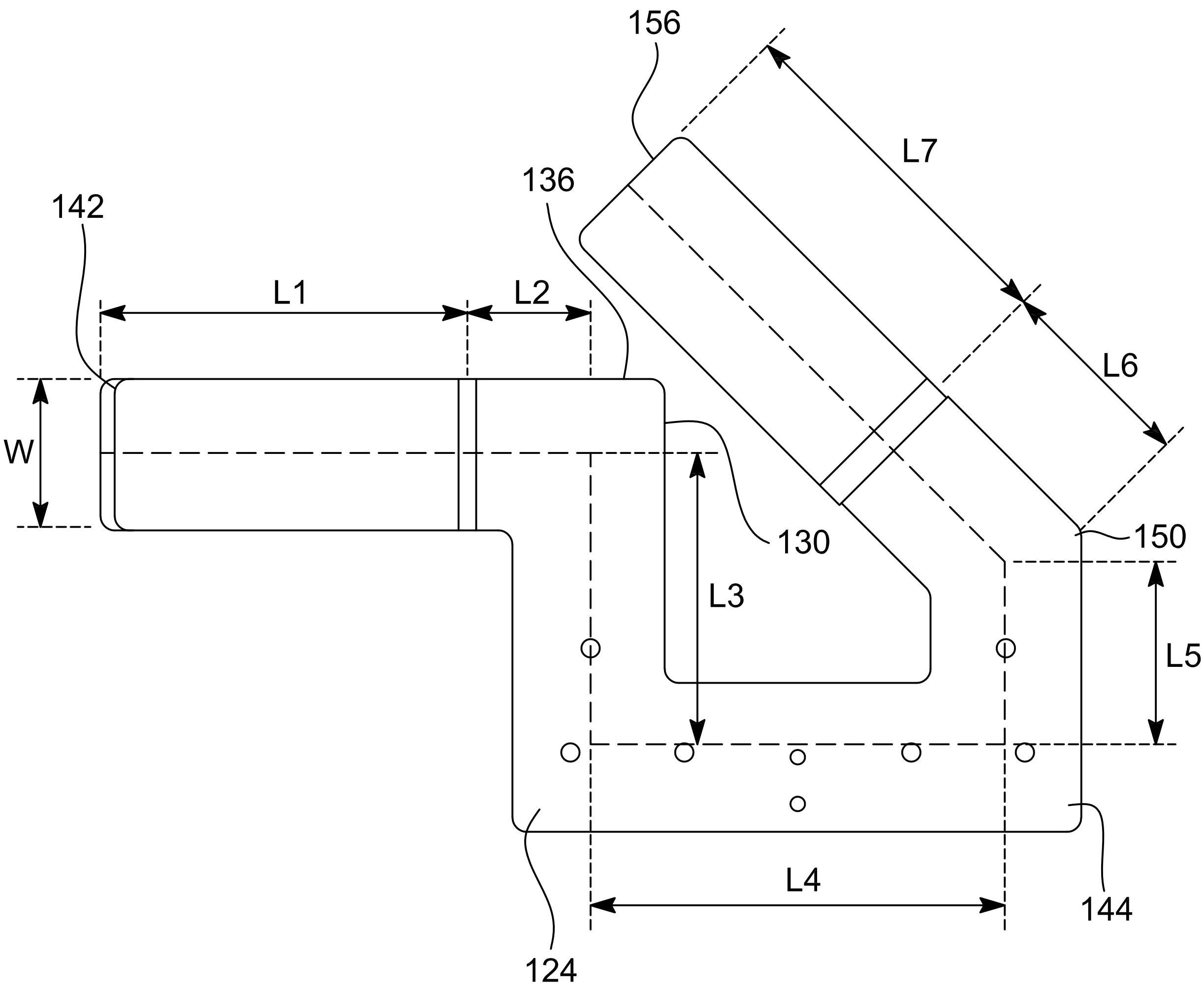

FIG. 3

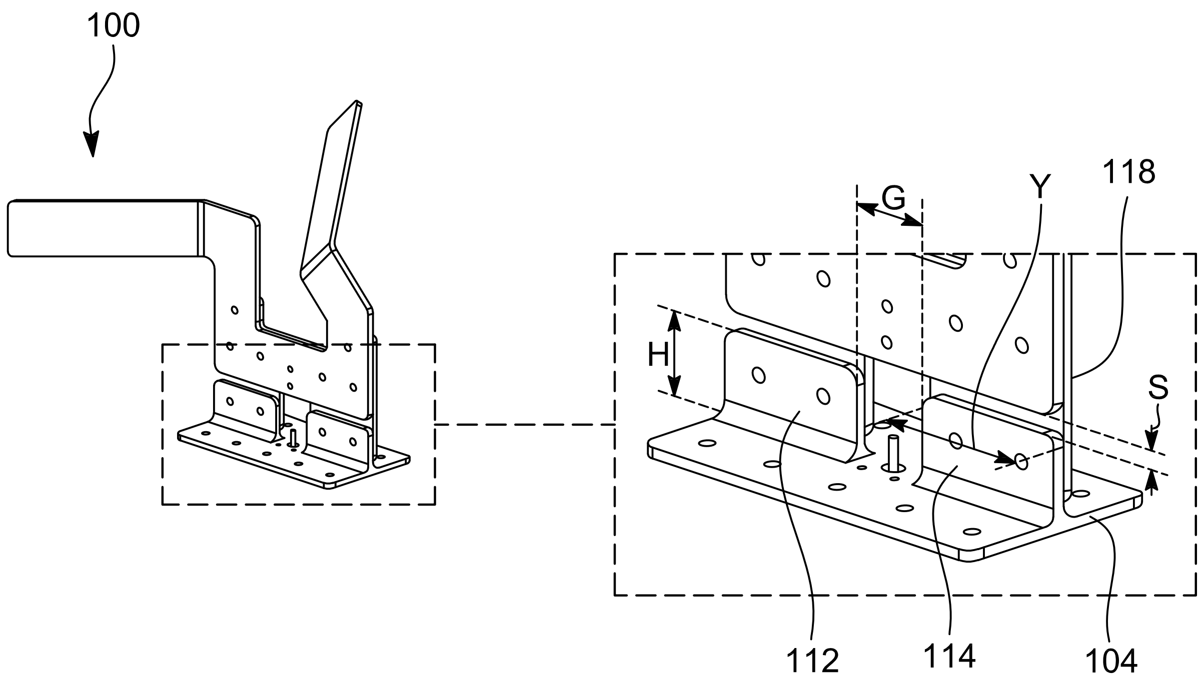

FIG. 4