

March 29, 1949.

A. G. KANDOIAN

2,465,379

ANTENNA UNIT

Filed Jan. 27, 1945

2 Sheets-Sheet 1

Fig. 1.

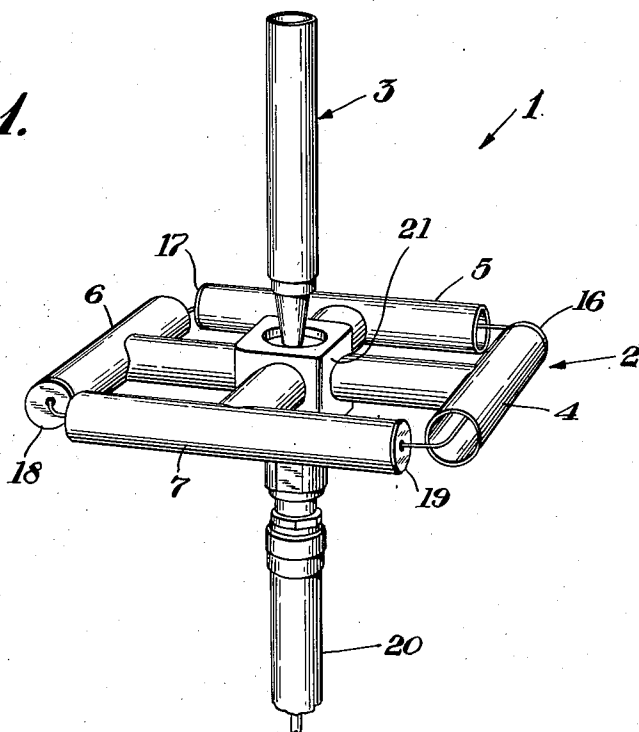


Fig. 2.

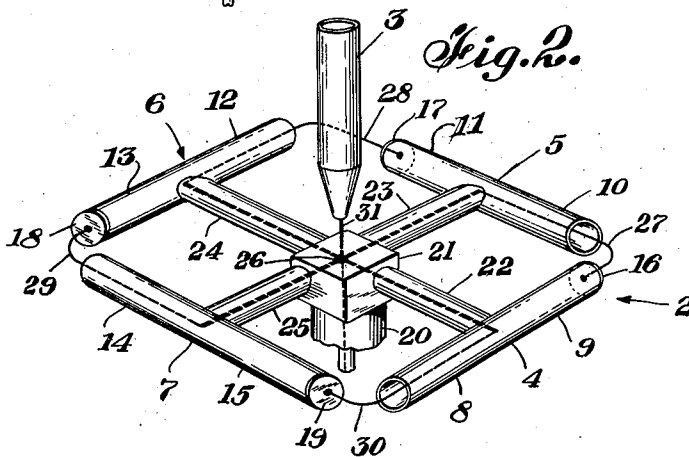
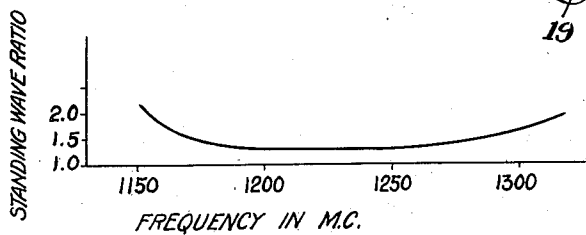


Fig. 3.



INVENTOR.
ARMIG G. KANDOIAN

BY

RPMorris
ATTORNEY

March 29, 1949.

A. G. KANDOIAN

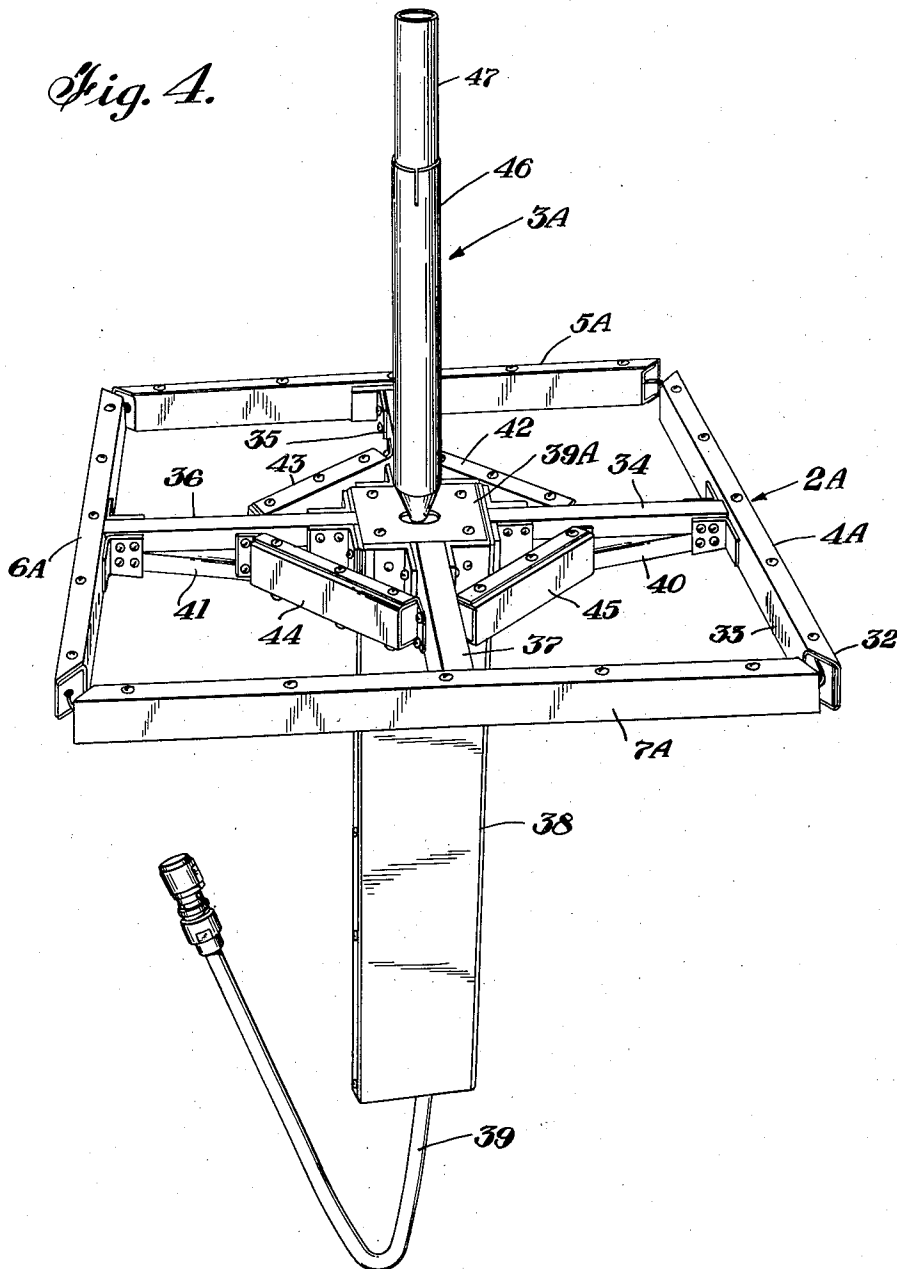
2,465,379

ANTENNA UNIT

Filed Jan. 27, 1945

2 Sheets-Sheet 2

Fig. 4.



INVENTOR.
ARMIG G. KANDOIAN
BY

RP Morris
ATTORNEY

UNITED STATES PATENT OFFICE

2,465,379

ANTENNA UNIT

Armig G. Kandoian, New York, N. Y., assignor to
Federal Telephone and Radio Corporation, New
York, N. Y., a corporation of Delaware

Application January 27, 1945, Serial No. 574,879

8 Claims. (Cl. 250—33.53)

1

This invention relates to antennas and more particularly to composite antenna construction or elliptically polarized radiation.

It is well known that a combination of the vertical and horizontal polarization will provide a resultant circular or elliptical polarization of radiations, depending upon whether the energies are equal in amplitude and are in phase quadrature. When energy substantially vertically polarized is desired this may be obtained from a vertical antenna. Horizontally polarized radiations may be had from a horizontal loop antenna, for example one of the type in which a plurality of radiators of half wavelength or less are mounted to provide a substantially closed periphery and are energized to oscillate as dipoles.

It is an object of my invention to provide a novel antenna structure which will operate to provide elliptically or circularly polarized waves.

It is a further object of my invention to provide an antenna for circularly polarized energy which is simple in construction and design.

It is a still further object of my invention to provide a self-supporting antenna structure combining the characteristics of a horizontal loop and a vertical antenna.

According to a feature of my invention, I provide a horizontal loop antenna of the type designed to radiate predominantly horizontally polarized energy. This loop is preferably designed for feeding from a single coaxial line. Such a loop produces a radiation pattern of lemniscate form. Centrally of the loop is mounted a vertical radiator which is coupled for feeding to the inner conductors of the concentric or coaxial line branches which serve to feed the loop radiating members. This vertical antenna has a vertically polarized pattern of similar shape to the pattern of the loop. The loop and vertical antennas are preferably designed to provide impedance matching of the various elements with the supporting coaxial line. Preferably, the vertical radiator and the horizontal loop are of equal impedance so that the energy fed thereto will divide equally between the two. In this case if the phasing of the energy is also in quadrature, circularly polarized energy will result.

In practice, the exact phase relationship between the vertically polarized components and horizontally polarized components of the field is not of primary importance because during propagation each of these components is affected differently by the propagation and reflection medium.

2

A better understanding of my invention and the objects and features thereof may be had from the particular description thereof made with reference to the accompanying drawings, in which:

Fig. 1 is a perspective illustration of one form of antenna in accordance with my invention;

Fig. 2 is a diagrammatic showing illustrating the conductor arrangement of the antenna of Fig. 1;

Fig. 3 shows a typical impedance matching curve over a frequency band of an antenna in accordance with my invention; and

Fig. 4 is a modified structural design of an antenna shown in accordance with my invention.

Turning first to Figs. 1, 2 and 3, the antenna 1 comprises a horizontal loop radiator 2 and concentrically mounted above it a vertical radiator 3. The horizontal loop radiator is of the type designed to produce substantially pure horizontally polarized energy and is preferably of the design more fully described in my co-pending application entitled "Loop antenna," Serial No. 574,878, filed of even date herewith. The horizontal radiator 2 as shown in Fig. 1 comprises hollow radiant acting members 4, 5, 6 and 7 each of which may be considered as being in two sections 8, 9; 10, 11; 12, 13; and 14, 15 as shown in Fig. 2. The two sections are joined together at the midpoint of members 4, 5, 6 and 7, respectively, and may be integral so that each radiant acting member is a simple continuous tube. The members 4, 5, 6 and 7 are positioned to provide a substantially closed planar periphery enclosing a substantially symmetrical area. One end of each of members 4, 5, 6 and 7 is preferably closed by means of conductive discs 16, 17, 18 and 19, respectively. A coaxial feeder line 20 is connected to a central junction box 21 from which are branched four coaxial branch lines 22, 23, 24 and 25. The outer conductor of each of these branch lines is directly connected to their respective radiating members 4, 5, 6 and 7 at the central nodal points. The inner conductor of coaxial line 20 is connected in the junction box 21 with one end of the inner conductors of branch lines 22, 23, 24 and 25 at a common feeder point 26. Preferably, radiant acting members 4, 5, 6 and 7 are each substantially one half wavelength at the mid-frequency of the operating frequency band. The other ends of the inner conductors of lines 23, 24, 25 and 22 are connected by conductor means 27, 28, 29 and 30, respectively, to the end plates or discs 16, 17, 18 and 19 of members 4, 5, 6 and 7, respectively. These conductors 27, 28, 29 and 30 extend through sections 10,

3

12, 14 and 8, of members 5, 6, 7 and 4, respectively, thus providing in these sections effectively other coaxial transmission lines. As a consequence, the line sections 8, 10, 12 and 14 and branch lines 22, 23, 24 and 25 may serve as impedance transformers which may transform the impedance at the coupling point of radiant acting members 4, 5, 6 and 7 to a desired value at the point wherein they are coupled to transmission line 20.

The loop circuit so far described is in effect the loop circuit described in my aforementioned patent application, Serial No. 574,878. This loop will produce substantially horizontal polarized radiations of lemniscate form. In order to provide the desired vertical polarized radiations, vertical antenna 3 is coupled by means of a conductor 31 to junction point 26 of the coaxial line inner conductors. Radiator 3 is preferably so formed as to have a substantially cylindrical radiating surface. Its main portion, therefore, can be made from a length of straight tubing which is suitably dimensioned to have the desired impedance so that the sum of the impedances of radiators 2 and 3 will preferably be equal to the characteristic impedance of line 20. Accordingly, a complete unitary structure for producing elliptically or circularly polarized waves without the necessity of additional impedance matching sections is provided. The division of energy between antennas 2 and 3 may be controlled by controlling the impedance of antenna units 2 and 3, respectively. Thus if circularly polarized energy is desired, the impedances of 2 and 3 should be equal to one another and the energy supplied thereto should be in phase quadrature. If elliptically polarized energy is desired then there may be a difference in impedance between the two antennas or a phase shift in the energy supplied to antenna units 2 and 3 or both. The degree of phase shift and/or departure from equality of impedance will serve to determine the amount of departure of the polarization of the resultant radiation from circular.

For circularly polarized energy it has been found that vertical antenna 3 should generally be made between a quarter and a half wavelength long (in the order of .4 wavelength) dependent upon the constants of the other radiation elements. In a typical example of a composite antenna of the type disclosed herein for operation in the neighborhood of 1200 megacycles, the characteristic impedance may be substantially as shown in Fig. 3. According to this figure it can be seen that if a 2 to 1 mismatch in impedance on the feeder line is tolerable, the antenna will operate over a frequency band from about 1175 megacycles to about 1250 megacycles.

Likewise it can be seen that the complete antenna structure is self-supporting and needs no insulator structural members.

In Fig. 4, is shown another structural embodiment of an antenna incorporating the features of my invention designed for operating at longer wavelengths than the antenna of Fig. 3. The coaxial loop members of antenna 2A are made of substantially rectangular form and may comprise two channel sections 32 and 33 fastened together by any suitable means. The members 4A, 5A, 6A and 7A are supported by cross arms 34, 35, 36 and 37.

A hollow supporting mast 38 to which the arms 34, 35, 36, and 37 are fastened at 39A serves to support the antenna structure. A coaxial feeder

4

line 39 extends upwardly through mast 38, and is branched to feed energy to the loop as shown at 40 and 41.

The corresponding lines for arms 35 and 36 are not visible in this view. Bracing arms 42, 43, 44 and 45 are provided to hold rigid arms 34, 35, and 36, respectively. It will therefore be clear that this structure lends itself to rigidity of construction even for relatively long radiant acting members. The vertical radiator 3A is made in two sections 46 and 47 so that this antenna may be adjusted in length in accordance with the desired impedance value. The antenna, however, is substantially the same so far as the electrical properties are concerned as that described in connection with Figs. 1, 2 and 3.

It should be clearly understood that the illustrations given are merely by way of example. In any of these embodiments, the vertical antennas may be made adjustable in length to secure the desired impedance and phase action. Furthermore, while I have illustrated a simple four-arm horizontal loop, this loop may comprise any desired number of elements. It will likewise be clear that the structure provides connection for the coaxial lines and supporting means at minimum voltage points of the radiant acting members so that no insulation of the antenna from the ground or other objects need be provided. Furthermore, the impedance value of the radiating members and the vertical antenna may be controlled by choosing radiators of different radial dimensions. The impedance matching transformers comprising the coaxial line systems of the horizontal loop may be also designed by proper choice of the inner to outer conductor ratios to secure the desired impedance values for matching the feeder transmission line.

It should be clearly understood that the examples shown and described in this application are given merely by way of example and are not to be considered as limitations of my invention as set forth in the objects thereof and in the appended claims.

I claim:

1. An antenna comprising a first antenna unit including a plurality of hollow, substantially horizontal radiant acting members arranged substantially to enclose a substantially symmetrical planar area, each of said members being substantially a half wavelength long, a second antenna unit comprising a substantially vertical radiator between a half wavelength and a quarter wavelength long mounted substantially symmetrically of said area, the impedance of said first and second antenna being such as to provide a desired ratio, and coaxial feeder lines connected together at one end and having their outer conductors at the other ends fastened to voltage nodal points on said members, the connected inner conductors being connected to one end of said second antenna unit, the other ends of said inner conductors extending in one direction through the hollow conductive members and being fastened to one end of the next adjacent radiant acting member.

2. An antenna comprising a first antenna unit including a plurality of hollow, substantially horizontal radiant acting members arranged substantially to enclose a substantially symmetrical planar area, each of said members being substantially a half wavelength long, a second antenna unit comprising a substantially vertical radiator between a half wavelength and a quarter wavelength long mounted substantially symmet-

5

rically of said area, the impedance of said first and second antenna being such as to provide a desired ratio, coaxial feeder lines connected together at one end and having their outer conductors at the other ends fastened to voltage nodal points on said members, the connected inner conductors being connected to one end of said second antenna unit, the other ends of said inner conductors extending in one direction through the hollow conductive members and being fastened to one end of the next adjacent radiant acting member, and a coaxial energy line having its outer conductor fastened to the outer conductors of said feeder lines, and its inner conductor fastened to the junction point of the inner conductors of said feeder lines.

3. An antenna structure for providing substantially circularly polarized radiation, comprising a first antenna unit including a plurality of substantially horizontal hollow radiant acting members, said members being arranged with ends adjacent to provide a substantially closed periphery, branch coaxial lines extending from said members to a point substantially symmetrically arranged within said periphery, the outer conductors of said branch lines being connected respectively to said members at voltage nodal points of said members, and the inner conductors of said branch lines being extended within each member in one direction around said periphery and connected to the end of next adjacent member, a second antenna unit comprising a substantially vertical linear antenna mounted above the plane defined by said members with one end adjacent said common feeder point, and a conductor means interconnecting the lower end of said vertical antenna and the inner conductors of said branch lines at said feeder point, the impedances of said first and second units being substantially the same, a coaxial feeder line for supplying energy to and supporting the said units, said last-named line having an impedance substantially equal to parallel impedance of said antenna units, and means for connecting the inner conductor of said coaxial line with the inner conductors of said branch lines, and the outer conductor of said coaxial line with the outer conductors of said branch lines at said feeder point.

4. An antenna structure for providing substantially circularly polarized radiation over a relatively broad frequency band comprising a first antenna unit including a plurality of substantially horizontal, hollow radiant acting members each member having two substantially equal-length interconnected sections, said members each being substantially a half wavelength long at the middle of said band and arranged with their ends adjacent one another to provide a substantially closed periphery, branch coaxial lines extending from the connection points of said sections to a common feeder point substantially symmetrically arranged within said periphery, the outer conductors of said branch lines being connected respectively to said members at the connection points of said sections, and conductors arranged within one section of each member and connected at one end to the central conductor of its respective line and at the other end to the next adjacent member, a second antenna unit comprising a substantially vertical antenna in the order of four tenths wavelength at the upper end of said band mounted above the plane defined by said members with one end adjacent said common feeder point, and a second conductor means interconnecting the lower end of said

6

vertical antenna and the inner conductors of said branch lines at said feeder point, the impedances of said first and second units being substantially the same, a coaxial feeder line for supplying energy to and supporting the said units, said last-named line having an impedance substantially equal to the parallel impedance of said antenna units, and means for connecting the inner conductor of said coaxial line with the inner conductors of said branch lines, and the outer conductor of said coaxial line with the outer conductors of said branch lines at said feeder point.

5. An antenna structure for providing radiation having components polarized in perpendicular related planes, comprising a first antenna unit including a plurality of substantially radiant acting members each member having two substantially equal-length interconnected sections, said members being arranged in one plane with their ends adjacent one another to provide a substantially closed periphery, branch coaxial lines extending from the connection points of said sections to a common feeder point substantially symmetrically arranged within said periphery, the outer conductors of said branch lines being connected respectively to said members at the connection points of said sections, and conductors arranged within one section of each member and connected at one end to the central conductor of its respective line and at the other end to the next adjacent member, a second antenna unit comprising an antenna adjustable in length mounted perpendicular to and above the plane defined by said members and having one end adjacent said common feeder point, and a second conductor means interconnecting the lower end of said vertical antenna and the inner conductors of said branch lines at said feeder point, a coaxial feeder line for supplying energy to and supporting the said units, said last-named line having an impedance substantially equal to the parallel impedance of said antenna units, and means for connecting the inner conductor of said coaxial line with the inner conductors of said branch lines, and the outer conductor of said coaxial line with the outer conductors of said branch lines at said feeder point.

6. An antenna structure for providing circularly or elliptically polarized radiation, comprising a first antenna unit including a plurality of substantially horizontal radiant acting members each member being substantially a half wave length long each member having two substantially equal-length interconnected sections, said members being arranged with ends adjacent to provide a substantially closed periphery, branch coaxial lines extending from the connection points of said sections to a common feeder point substantially symmetrically arranged within said periphery, the outer conductors of said branch lines being connected respectively to said members at voltage nodal points of said members, and conductors arranged within one section of each member and connected at one end to the central conductor of its respective line and at the other end to the next adjacent member, a second antenna unit comprising a substantially vertical antenna mounted above the plane defined by said members with one end adjacent said common feeder point, and a second conductor means interconnecting the lower end of said vertical antenna and the inner conductors of said coaxial lines at said feeder point, a coaxial feeder line for supplying energy to and supporting the said units, said

last named line having an impedance substantially equal to the parallel impedance of said antenna units, and means for connecting the inner conductor of said coaxial line with the inner conductors of said branch lines, and the outer conductor of said coaxial line with the outer conductors of said branch lines at said feeder point.

7. An antenna structure for providing circularly polarized radiation, comprising a first antenna unit including a plurality of substantially horizontal radiant acting members each member having two substantially equal-length interconnected sections, said members being arranged with ends adjacent to provide a substantially closed periphery, branch coaxial lines extending from the connection points of said sections to a common feeder point substantially symmetrically arranged within said periphery, the outer conductors of said branch lines being connected respectively to said members at the connection points of said sections, and conductors arranged within one section of each member and connected at one end to the central conductor of its respective line and at the other end to the next adjacent member, a second antenna unit comprising a substantially vertical antenna mounted above the plane defined by said members with one end adjacent said common feeder point, and a second conductor means interconnecting the lower end of said vertical antenna and the inner conductors of said coaxial lines at said feeder point, the impedances of said first and second units being substantially the same, a coaxial feeder line for supplying energy to and supporting the said units, said last-named line having an impedance substantially equal to the parallel impedance of said antenna units, and means for connecting the inner conductor of said coaxial line with the inner conductors of said branch lines, and the outer conductor of said coaxial line with the outer conductors of said branch lines at said feeder point.

8. An antenna structure for providing circularly polarized radiation, comprising a first antenna unit including a plurality of substantially horizontal radiant acting members each member having two substantially equal-length interconnected sections, said members being arranged with their ends adjacent one another to

define a substantially closed periphery, branch coaxial lines extending from the connection points of said sections to a common feeder point substantially symmetrically arranged within said periphery, the outer conductors of said branch lines being connected respectively to said members at the connection points of said sections, and conductors arranged within one section of each member and connected at one end to the central conductor of its respective line and at the other end to the next adjacent member, a second antenna unit comprising a substantially vertical antenna mounted above the plane defined by said members with one end adjacent said common feeder point, and second conductor means interconnecting the lower end of said vertical antenna and the inner conductors of said branch lines at said feeder point, the impedances of said first and second units being substantially the same, a coaxial feeder line for supplying energy to and supporting the said units, said last-named line having an impedance substantially equal to the parallel impedance of said antenna units, and means for connecting the inner conductor of said coaxial line with the inner conductors of said branch lines, and the outer conductor of said coaxial line with the outer conductors of said branch lines at said feeder point.

ARMIG G. KANDOIAN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,841,654	Von Korschevsky	Jan. 19, 1932
1,892,221	Runge	Dec. 27, 1932
2,193,859	Buschbeck	Mar. 19, 1940
2,201,857	Dome	May 21, 1940
2,207,781	Brown	July 16, 1940
2,210,066	Cork et al.	Aug. 6, 1940
2,256,619	Luck	Sept. 23, 1941
2,282,030	Busignies	May 5, 1942
2,283,897	Alford	May 26, 1942
2,291,450	Case	July 28, 1942
2,391,026	McGuigan	Dec. 18, 1945
2,425,585	Wheeler	Aug. 12, 1947