United States Patent [19]

Ben-Dov

[11] **3,765,023**

[45] **Oct. 9, 1973**

[54] **CIRCULARLY POLARIZED ANTENNA**

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[22] Filed: **Sept. 21, 1972**

[21] Appl. No.: **291,063**

[52] **U.S. Cl.** **343/797,** 343/908

[51] **Int. Cl.** **H01q 21/26**

[58] **Field of Search** 343/797, 798, 818, 343/908

[56] **References Cited**

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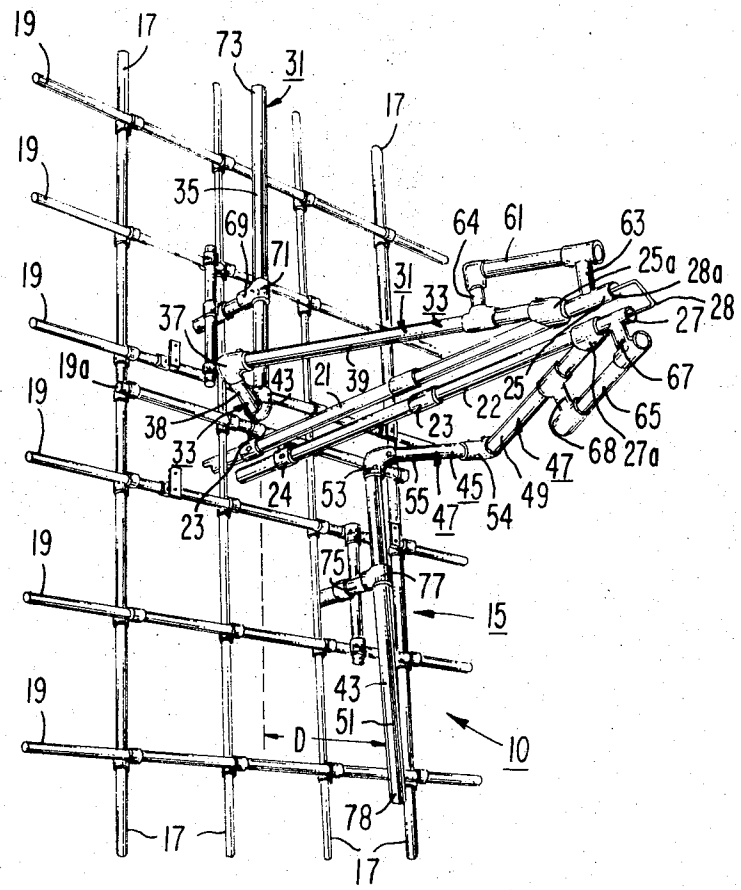
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Primary Examiner—Eli Lieberman
Attorney—Edward J. Norton et al.

[57] **ABSTRACT**

An antenna for launching and receiving circularly and eliptically polarized electromagnetic waves includes a pair of conductive elements. Each of the elements has a horizontal portion and a continuing vertical portion. The horizontal portions of the first and second elements are arranged to form a first center fed dipole oriented in the horizontal plane and the vertical portions of the first and second elements are arranged to form a second center fed dipole oriented in the vertical plane. The center feed point of the first dipole is spaced from the center feed point of the second dipole so that the phase center of the waves associated with the two dipoles are at phase quadrature.

6 Claims, 4 Drawing Figures



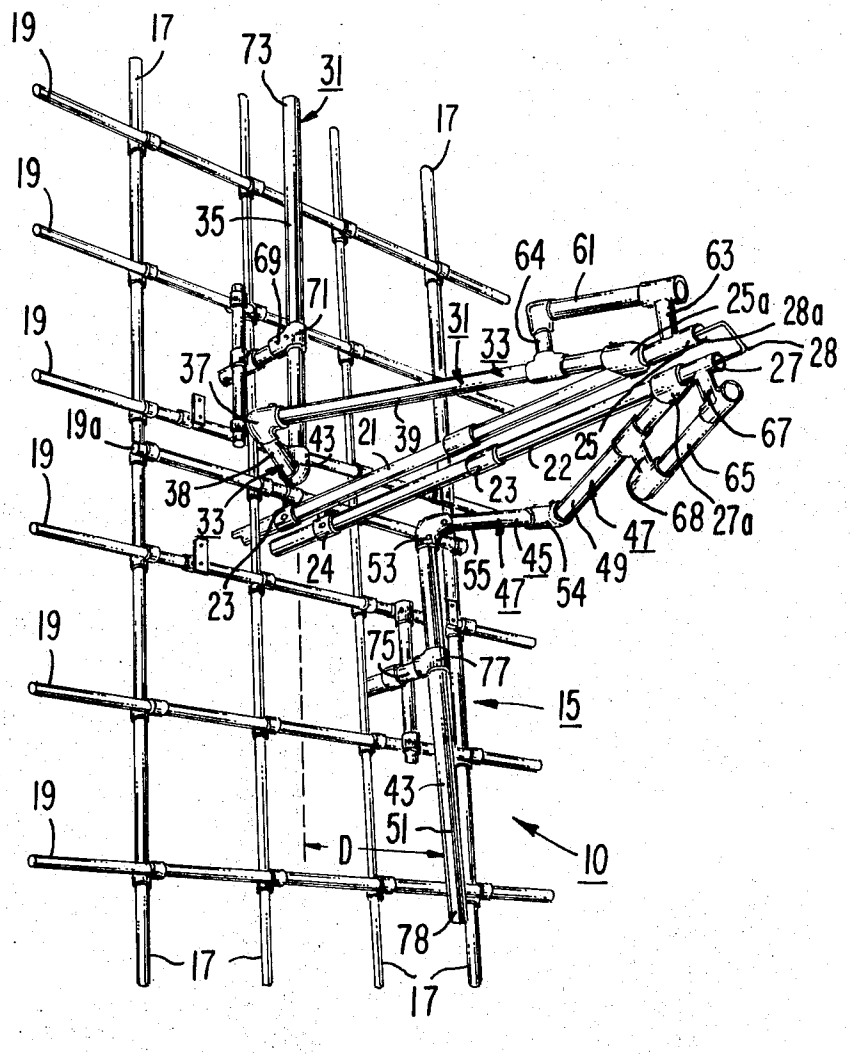

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Fig. 1.

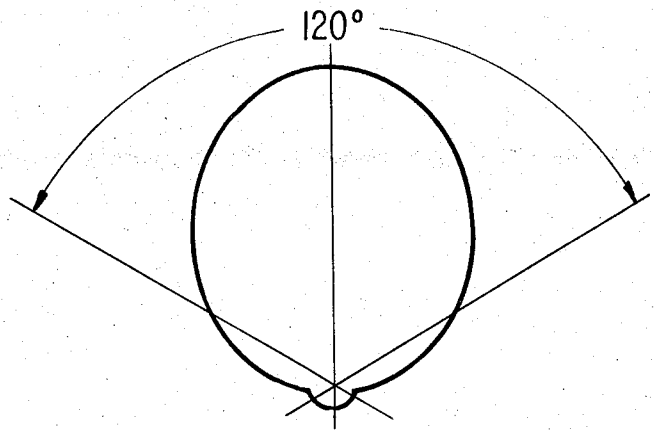


Fig. 2

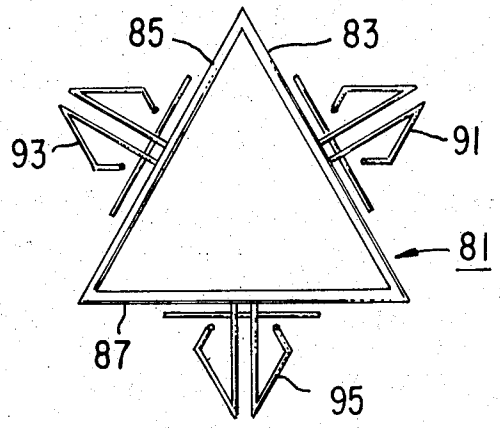


Fig. 3

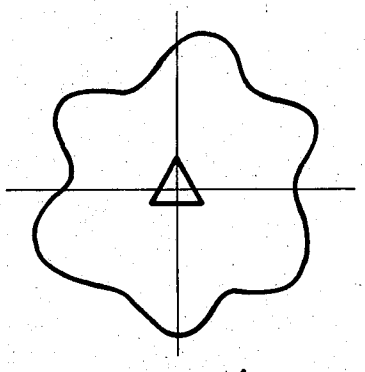


Fig. 4

CIRCULARLY POLARIZED ANTENNA

BACKGROUND OF THE INVENTION

This invention relates to an improvement in antennas of the type which radiate and/or receive circularly polarized electromagnetic waves.

In connection with radio and television broadcasting, it is known that to afford satisfactory reception regardless of the orientation of the receiving antenna with respect to the transmitting antenna, a circularly polarized transmitting antenna is desirable. It is also desirable that both the vertical polarization and the horizontal polarization radiation patterns be equal. Further, it is desirable that the azimuthal or horizontal radiation patterns have a substantially uniform beam width over the required bandwidth of about 120° so that, when three such antennas are mounted to a triangular tower which is already in use of other transmission purposes (for example television VHF broadcast), a substantially uniform omni-directional pattern can be achieved. If this omni-directional pattern is not achieved, then the reception about the coverage area of the radio broadcasting station is not uniform and hence usually undesirable.

Briefly, these desirable patterns are provided by a circularly polarized antenna of the present invention which is operable over a given frequency band. The antenna includes a first conductive element having a first and a continuing second portion spaced forward of a reflecting surface. A second conductive element having a first and a continuing second portion is spaced forward of the reflecting surface. The first portions of the first and second elements are symmetrically disposed relative to each other and extend in a common plane which is perpendicular to the reflecting surface in a manner to form a first center fed dipole fed at the free ends of the first portions. The second portion of the first element spaced from the reflecting surface extends parallel to the reflecting surface and perpendicular to and above the common plane of the two first portions. The second portion of the second element extends parallel to the reflecting surface and is perpendicular to and below the common plane to form with the second portion of the first element a second center fed dipole orthogonally oriented to the first dipole. The junction of the first and second portions of the first element and the junction of the first and second portions of the second element form the feed point of the second dipole. The straight line spacing between the feed points of the first and second center fed dipoles is made so that the phase center of the waves associated with the first dipole is at phase quadrature with the phase center of the waves associated with the second dipole. The RF electromagnetic signal energy at the operating frequency is fed to the first element and the second element to establish a standing wave on the antenna at the given frequency band.

DETAILED DESCRIPTION

A more detailed description follows in conjunction with the accompanying drawings in which:

FIG. 1 is a perspective view showing a circularly polarized antenna mounted forward of a reflector screen.

FIG. 2 illustrates a typical horizontal pattern for an antenna as shown in FIG. 1.

FIG. 3 is a top plan view of three antennas as in FIG. 1 mounted on a triangular tower.

FIG. 4 illustrates a typical horizontal pattern for an antenna system arrangement as shown in FIG. 3.

Referring to FIG. 1, the antenna **10** is customarily mounted on an elevating support structure or tower not shown. The antenna **10** includes a pair of conductive elements **31** and **45** spaced from a screen reflector **15.** The screen reflector **15** is made up of a plurality of vertically extending rods **17** coupled to a plurality of horizontally extending rods **19.** A pair of horizontally extending hollow support arms **21** and **22** are coupled by clamps **23** and **24** to a center rod **19*a*** of the horizontally extending reflector rods **19.** The arms **21** and **22** extend perpendicular the screen reflector **15** with the ends **25** and **27** remote from the reflector **15** being the feed points or feed terminals for the elements **31** and **45** of the antenna **10.** The element **31** is connected to support arm **21** at point **25*a*** near end **25.** The element **45** is connected to support arm **22** at point **27*a*** near end **27.**

The first antenna element **31** comprises a first portion **33** oriented horizontal (parallel to the ground) and has a second portion **35** perpendicular to the first portion and extending vertically. The portion **33** includes a first section **39** and a second section **38** joined together at point **37.** The section **39** extends from a point **25*a*** close to the end **25** of arm **21** at an angle of about 30° away from arm **21** to the point **37.** The section **39** is approximately one-quarter wavelength long at the center operating frequency of the antenna. The section **38** is at right angles to section **39** and extends to point **43** approximately ⅛ wavelength at the center operating frequency of the antenna from point **37** to point **43.** The sections **38** and **39** of portion **33** lie in a common plane which is substantially perpendicular to the reflector **15.** The overall length of conductive portion **33** is about three-eights of a wavelength at the center operating frequency of the antenna. The straight line length in space between points **43** and **25** is approximately ⅛ wavelength at the center operating frequency of the antenna.

The portion **35** is substantially vertical and perpendicular to the plane formed by portion **33** and is parallel to and spaced from the vertical rods **17** of reflector **15.** The vertical portion **35** is approximately three-eighths of a wavelength long at the center operating frequency of the antenna and extends above the plane formed by portion **33.**

The antenna **10** includes the second antenna element **45** having a horizontally extending first portion **47** symmetrically disposed relative to the first portion **33** and a vertically extending second portion **51.** The first portion **47** and the second portion **51** are joined at point **53.** The first portion **47** includes substantially horizontally extending first section **49** which extends in the same plane as portion **33.** The section **49** extends for a length of approximately a quarter wavelength at the center operating frequency of the antenna between a point **27*a*** close to end **27** and point **54** and at an angle of 30° away from arm **22** to point **54.** The horizontally extending portion **47** includes a second section **55** which is joint to section **49** at the point **54** to form a right angle therewith. The section **55** extends toward the arms **21** and **22** for a length of about an eight of a wavelength at the center operating frequency to point **53.** The horizontally extending sections **39** and **49** are approximately at an angle of 60° relative to each other.

The vertical portion **51** extends parallel to the reflecting surface **15** and the rods **17** and extends for a length of about three-eighths of a wavelength long at the center operating frequency of the antenna from point **53**. The second portion **51** extends below the plane formed by first portions **33** and **47**. The vertical portions **35** and **51** are offset from alignment with each other by a distance D equal to about one-tenth of a wavelength at the center operating frequency to achieve a vertical polarization beam width of 120°. By placing the horizontally extending members as shown with sections **39** and **49** at an angle of about 60° with respect to each other and forward of reflecting surface **15**, a horizontal polarization beam width of about 120° is obtained.

The antenna is coupled to a coaxial transmission line that extends through the inside of hollow arm **21**. The outer conductor **28a** of this coaxial transmission line is connected to end **25** of arm **21** and consequently to one end of first antenna element **31**. The inner conductor **28** of the coaxial transmission line is connected to end **27** of arm **22** and consequently to one end of the second element **45**. The opposite end of this coaxial transmission line is coupled to an appropriate source or load, not shown. It has been found that by making the spacing between the feed points **43, 53** of the vertical portions **35, 51** and the feed points **25, 27** of the horizontal portions **33** and **47** approximately one-third of a wavelength at the center operating frequency of the antenna, the phase center of the waves associated with the vertical dipole and the phase center of the waves associated with the horizontal dipole are effectively at about phase quadrature (90° phase difference) and circular polarization is achieved.

To provide improved impedance matching for a relatively low impedance transmission line such as 50 ohms, for example, and for adjusting the phase centers of the waves associated with the vertical dipole so as to more closely achieve effective phase quadrature between these waves, a pair of matching elements **61** and **65** are provided. The first matching element **61** is spaced by elements **63** and **64** a distance of about 8 inches parallel to section **39** of portion **33**. Spacer element **63** is coupled to arm **21** at end **25** and to element **61**. Spacer element **64** is coupled to section **39** and element **61**. Element **61** is approximately **19** inches long. The second matching element **65** is spaced parallel to section **49** of portion **47** by elements **67** and **68**. Spacer element **67** is coupled between arm **22** at end **27** and element **65**. Spacer element **68** is coupled between section **49** and element **65**. The element **65** is about 19 inches long and spaced about eight inches from element **49**. In the above described arrangement the desired patterns were achieved for the dimensions given when operating at 90 MHz.

Added support for the vertical elements **35** and **51** can be provided by connecting a support **69** between rods **19** of reflector **15** and portion **35** at point **71** one-quarter wavelength away at the operating frequency of the antenna from tip **73** of portion **35**. The vertical element **51** is additionally supported by support **75** coupled between the rods **19** of reflector **15** and point **77** of portion **51**. Point **77** of portion **51** is located one-quarter of an operating frequency wavelength from the tip **78** of portion **51**.

Referring to FIG. **2**, there is illustrated a typical horizontal pattern with relative field strengths for an antenna of the type described above in connection with FIG. **1**. It can be noted that a substantially uniform beam width pattern of 120° is provided.

Referring to FIG. **3**, a tower **81** is described having sides **83, 85** and **87**. With three such circularly polarized antennas and their associated reflectors **91, 93** and **95** of the type described in FIG. **1** mounted to the sides of the tower as shown in FIG. **3**, a substantially uniform omni-directional pattern as shown in FIG. **4** is provided.

What is claimed is:

1. A circularly polarized antenna operable over a given frequency band comprising:

a reflecting surface,

a first conductive element having a first portion and an electrically continuous second portion spaced forward of said reflecting surface,

a second conductive element having a first portion and an electrically continuous second portion spaced forward of said reflecting surface,

means coupled to a terminating end of each of said conductive elements for feeding RF electromagnetic signal waves between said first conductive element and said second conductive element at a terminal end thereof to establish a standing wave on said conductive elements at said given frequency,

said first portion of said first element and said first portion of said second element being symmetrically disposed relative to each other and extending in a common plane to form a first dipole spaced from said reflecting surface,

said second portion of said first conductive element extending parallel to said reflecting surface and perpendicular to and above said common plane, said second portion of said second conductive element extending parallel to said reflecting surface and perpendicular to and below said common plane to form with the second portion of said first element a second dipole orthogonally oriented to said first dipole. said first conductive element and said second conductive element being further arranged so that the straight line spacing between the junctions of the first portion and second portions of said conductive elements and said terminating ends is sufficient to effectively accomplish quadrature phasing between the phase centers of the waves at said first dipole and said second dipole.

2. The combination as claimed in claim **1** wherein said first portion of said first conductive element and said first portion of said second conductive element near the feed terminating end of these elements are at an angle with respect to each other of about 60°.

3. The combination as claimed in claim **1** wherein said first and second portions of said first and second conductive elements are each about three-eighths of a wavelength long at a frequency within said given frequency band.

4. The combination as claimed in claim **3** wherein the second portion of said first conductive element is offset from alignment with the second portion of the second conductive element by a distance $d = \lambda/10$, where λ is a wavelength at a frequency within said frequency band.

5. The combination as caimed in claim **1** wherein each of said first portions has two sections at right angles with respect to each other.

6. The combination as claimed in claim **5** wherein a first section of said two sections is approximately one-quarter wavelength at said operating frequency.

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