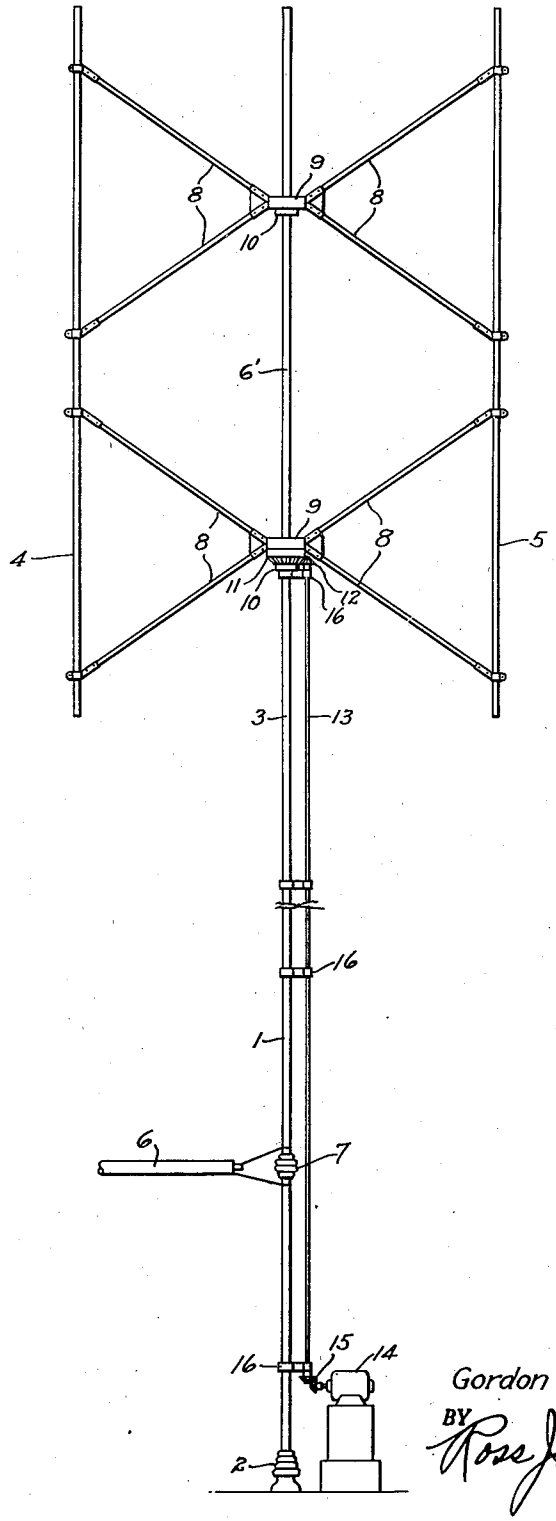
Oct. 26, 1948. G. H. COTCHEFER 2,452,106

RADIO ANTENNA

Filed March 16, 1946



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Patented Oct. 26, 1948

2,452,106

UNITED STATES PATENT OFFICE

2,452,106

RADIO ANTENNA

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Application March 16, 1946, Serial No. 654,840

12 Claims. (Cl. 250—33.57)

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This invention relates to radio reception and transmission, and particularly to an antenna array suitable for both omnidirectional transmission and reception to and from nearby points, and unidirectional transmission and reception to and from distant points.

Radio antenna arrays now in common use are designed primarily for transmission and reception to and from distant points and are usually in the form of a series of parallel horizontal or vertical elements of equal length, one being the driven element to which the transmission line leading to the radio receiver or transmitter is attached, and the others being parasitic or driven elements employed to beam the transmission or reception in a single direction. Such antennas do not provide for omnidirectional transmission and reception, and if they are to be employed for transmission or reception to and from stations located in different directions, it is necessary that provision be made for rotating the entire array. This is particularly awkward for a horizontal array. Since the transmission line leading from antenna to the radio receiver or transmitter is normally a double line, attached at two points to the antenna, it is clear that the rotation of the antenna must be confined to relatively narrow limits to avoid twisting the transmission line around the antenna support. This is avoided in some instances by the use of slip rings for making contact between the antenna and the transmission line, but the use of such slip rings involves possible loss of power and faulty operation.

It is an object of this invention to provide an antenna array which permits both omnidirectional transmission and reception to and from local points as well as unidirectional transmission and reception to and from distant points. Further objects are to supply a vertical antenna of simple construction providing for full 360° rotation in either direction without twisting of the transmission line, without the use of slip ring brushes or other moving devices; to avoid the necessity for running the transmission line to the top of the antenna in order to accomplish impedance matching between the array and transmission line supplying energy; to simplify the construction of an efficient unidirectional antenna; and to provide other advantages as will be brought out below.

Briefly the antenna array of this invention comprises a stationary vertical driven element having a height equal to at least two or any higher integral number of half-wavelengths, equipped with one or more parasitic elements of approximately

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one-half wavelength in height located adjacent the top one-half wavelength section of the driven element, and a transmission line connected to the bottom half-wavelength section of said driven element. Means are also provided for rotating the parasitic elements about the stationary driven element.

The invention will become clearer by reference to the attached drawing, in which driven element 1 has a total height from its top to base insulator 2 of any integral number of half wavelengths greater than 1. The length of element 1 down to point 3 is one-half wavelength, and parasitic elements 4 and 5, located adjacent and parallel to this top section of element 1 are also of one-half wavelength in height. The length of element 1 below point 3 is equal to any integral number of half wavelengths. Coaxial transmission line 6 is connected to the bottom one-half wavelength section of element 1, across insulator 7 which is located at one-fourth wavelength from base insulator 2. The parasitic elements 4 and 5 are maintained in position by means of struts 8, connected to center supports 9 which are drilled so as to rotate freely about element 1. Supports 9 are supported on fixed thrust bearings 10, which may be ball bearings if desired. The lower support 9 is equipped with gear 11 which is driven by gear 12 attached to shaft 13. Shaft 13 is in turn driven by motor 14 through gears 15 and is supported by brackets 16. Elements 1, 4 and 5 are made of metals which are good conductors, but the equipment touching them, except of course the transmission line, should be made of poorly conducting or insulating materials.

In operation, the antenna is rotated to the desired direction by means of motor 14, which is operated by conventional control means not shown, and the receiver or transmitter is connected to the other end of transmission line 6 by conventional means not shown, and the reception or transmission is begun. Transmission line 6, being connected to the bottom one-half wave section of element 1 at the one-fourth wavelength point, is matched in impedance by transformer action of element 1 with a point 6' located at the middle of the top half wave section of element 1 when the element 1 is an integral number of half wavelengths in height. The impedance of element 1 at the one-fourth wavelength feed point where feed insulator 7 is located is in the order of 55 to 75 ohms, which is readily matched by the use of a suitable coaxial transmission line. If a 2-wire transmission line of 600–1200 ohms impedance is employed, insulator 7 is not used, and

one of the two feed wires is merely insulated from any contact with the antenna and the other is connected to element 1 at a point near its extreme lower end at which point its impedance is matched by that of element 1. The point of connection of the transmission line is determined by well known principles of radio. The lower portion of element 1 from base insulator 2 to point 3 radiates omnidirectionally as a simple vertical antenna while the upper portion of element 1 above point 3, together with the parasitic elements 4 and 5 radiates in a unidirectional manner as a result of the combined reflective action of one of the parasitic elements and the directive action of the other.

As a specific example of an antenna of this invention an antenna suitable for use at a 28.6 megacycle frequency (approximately 10 meters wavelength) was constructed. Element 1 was made of Dural tubing assembled in sections of approximately 1¼ inch diameter, the length of element 1 from point 2 to insulator 7 being 8.2 feet and the length of element 1 above insulator 7 being 41 feet. Elements 4 and 5 were made of ½ inch Dural tubing approximately 15 feet in length. Thus the total length of element 1 was approximately 1½ wavelengths, and the length of elements 4 and 5 was approximately one-half wavelength. Struts 8 were made of hardwood, the brackets connecting them to elements 1, 4 and 5 were made of insulating materials, and the remainder of the construction was substantially as indicated in the drawing. Transmission line 6 was a coaxial transmission line of approximately 70 ohms impedance. The entire structure was mounted on the ground and supported by guy wires. Reflector element 4 was located approximately 4.8 feet from element 1 and director element 5 was located at approximately 3 feet from element 1 on the opposite side from element 4, the three elements 1, 4 and 5 lying in the same plane. The antenna operated very satisfactorily for both local and distant reception and transmission.

It is apparent that the above antenna possesses many advantages over the conventional antennas now in use. For example, it eliminates the necessity of running the feed line to the top of the antenna, which is desirably mounted at a considerable height above ground or building top level. It eliminates the problem of matching the impedance of the transmission line to that of the mid-point of the conventional antenna array, since this is automatically accomplished by the auto-transformer action of elements 1, 4 and 5. It eliminates all restrictions on the degree of rotation of the directional array. It eliminates efficiency loss and maintenance problems encountered in the use of slip rings and brushes in the conventional rotating beam antenna arrays. It eliminates the necessity of rotating a beam antenna array for transmission or reception of nearby signals. It eliminates the problem of element misalignment encountered in the use of horizontal antenna arrays due to sagging and other causes. It eliminates the necessity for construction of large and heavy towers now used in horizontal conventional arrays. It eliminates the necessity for using thrust bearings and driving mechanisms heavy enough to support and rotate the conventional horizontal beam antennas. It simplifies problems of construction and dismantling, and requires relatively small space. It may even be employed in lifeboats at sea.

Many modifications of the above equipment may be used. The height of element 1 may be one wavelength or three or more half wavelengths. Director element 5 need not be used, or additional parasitic elements such as an additional reflector element in addition to elements 4 and 5 may be employed, although the three element array shown is preferred. The distance between the elements is readily calculated from known formulas and is generally between about one-tenth and two-tenths of a wavelength. The array may be stationary, but is preferably rotatable. Rotation may be accomplished by any means other than that shown, such as for example by means of a shaft located within element 1 and coaxial therewith, and leading to a gear at or near the top of element 1 whereby the parasitic elements are rotated. Other types of transmission lines may be used, whether coaxial or dual wire, although coaxial line of about 55 to 75 ohms impedance, connected across an insulator at the lower one-quarter wavelength point as indicated is preferred. The antenna may be designed for other wavelengths than the 10 meter wavelength of the specific example, the system being particularly suitable for wavelengths shorter than about 20 meters, i. e. frequencies greater than about 14 megacycles. Other materials of construction may be employed although tubing made of light-weight metals of high conductivity, such as Dural, aluminum and the like are preferred for both the driven and the parasitic elements.

Other modifications of this invention which would occur to one skilled in the art may be made and these are to be considered within the scope of the invention as defined in the following claims.

I claim.

1. An antenna array which comprises a straight vertical driven element capable of radiation over a height one-half nL where L is the wave-length and n is an integer greater than 1, a parasitic element of height one-half L adjacent the top one-half L section of the said driven element and a transmission line connected to the bottom one-half L section of said driven element.

2. An antenna array which comprises a straight vertical driven element capable of radiation over a height one-half nL where L is the wave-length and n is an integer greater than 1, a parasitic reflector element of height one-half L adjacent the top one-half L section of the said driven element, a parasitic director element of height one-half L adjacent the top one-half L section of the said driven element and located on the opposite side from the said reflector element, and in the same plane as said driven element and said reflector element, and a transmission line connected to the bottom one-half L section of said driven element at a point within approximately one-fourth L from its lower end.

3. An antenna array which comprises a straight vertical driven element capable of radiation over a height one-half nL where L is the wave-length and n is an integer greater than 1, a parasitic reflector element of height one-half L adjacent the top one-half L section of the said driven element, and a coaxial transmission line connected to the bottom ½ L section of said driven element across an insulator at a point approximately one-fourth L from its lower end.

4. An antenna array which comprises a straight vertical driven element capable of radiation over a height one-half nL where L is the wave-length and n is an integer greater than 1, a parasitic reflector element of height one-half L adjacent the top one-half L section of the said driven element, and a two-wire transmission line connected

to the bottom one-half L section of said driven element at a point near its extreme lower end.

5. An antenna array which comprises a stationary straight vertical driven element capable of radiation over a height one-half nL where L is the wavelength and n is an integer greater than 1, at least one parasitic element adjacent to and in the plane of the top one-half L section of the said driven element, means for rotating said parasitic element about said driven element as an axis, and a transmission line connected to the bottom one-half L section of said driven element.

6. An antenna array which comprises a stationary straight vertical driven element capable of radiation over a height one-half nL where L is the wavelength and n is an integer greater than 1, at least one parasitic element adjacent to and in the plane of the top one-half L section of the said driven element, means for rotating said parasitic element about said driven element as an axis, and a coaxial transmission line connected to the bottom one-half L section of said driven element across an insulator at a point approximately one-fourth L from its lower end.

7. An antenna array according to claim 6 in which the coaxial transmission line has an impedance between about 55 and 75 ohms, and the inner conductor is connected above the insulator and the shell is connected below the insulator.

8. An antenna array according to claim 6 in which the driven element and the parasitic elements are constructed of light weight metal tubing.

9. An antenna array which comprises a stationary straight vertical driven element capable of radiation over a height 3/2 L where L is the wavelength, two parasitic elements of height one-half L located adjacent the top one-half L section of the said driven element on opposite sides

thereof and lying in a plane therewith, means for rotating said parasitic elements about said driven element as an axis, and a coaxial transmission line having an impedance between about 55 and 75 ohms connected to said driven element across an insulator at a point approximately one-fourth L from its lower end.

10. An antenna array according to claim 8 in which the wavelength is below about 20 meters.

11. An antenna according to claim 8 in which the wavelength is approximately 10 meters.

12. A vertical antenna system which comprises a section capable of omnidirectional radiation and a section capable of unidirectional radiation, the driven element of the latter section being directly connected to and in a straight line with the section capable of omnidirectional radiation, and each of said sections being approximately ½ wave length in height.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,966,491	Ferrell	July 17, 1934
2,149,333	Brown	Mar. 7, 1939
2,188,389	Cork et al.	Jan. 30, 1940
2,199,050	Jenkins	Apr. 30, 1940
2,243,523	Davis	May 27, 1941
2,255,520	Schuster	Sept. 9, 1941

OTHER REFERENCES

The A. R. R. L. Antenna Book, published by American Radio Relay League, West Hartford, Conn., 1944, pages 128, 129.