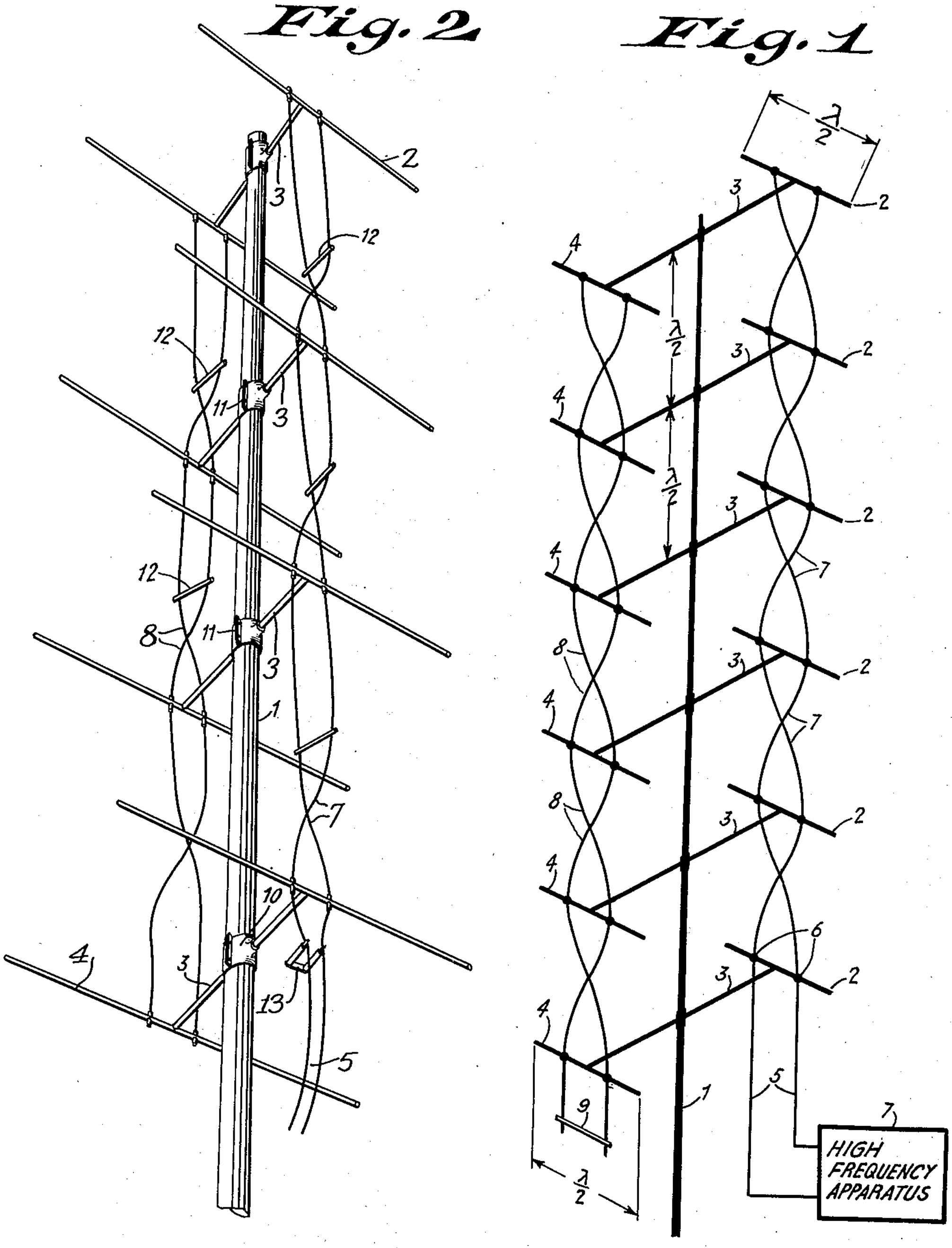
Dec. 19, 1939. P. S. CARTER 2,183,784

DIRECTIONAL ANTENNA

Original Filed Jan. 4, 1935

Fig. 2 Fig. 1



INVENTOR
P. S. CARTER
BY H. G. Grover
ATTORNEY

Patented Dec. 19, 1939

2,183,784

UNITED STATES PATENT OFFICE

2,183,784

DIRECTIONAL ANTENNA

Philip S. Carter, Port Jefferson, N. Y., assignor to Radio Corporation of America, a corporation of Delaware

Application January 4, 1935, Serial No. 342
Renewed September 29, 1938

19 Claims. (Cl. 250—11)

This invention relates to directional antennae, and more particularly to constructions wherein a plurality of dipoles are employed for communication on short waves.

One of the objects of the invention is to provide a simple, rigid and easily erected construction for an antenna comprising a plurality of dipoles. Another object is to provide an efficient antenna structure which is inexpensive to build and maintain, and which enables ready adjustment of the spacing between individual dipoles.

A feature of the invention is the all-metal structure employed for the supporting mast, the cross braces and the arms of the dipole without the use of any insulating members between them.

Another feature lies in the manner of interconnecting the wires between adjacent dipoles. According to the invention the feed wires between adjacent dipoles are reversed as to position in order to insure correct phase of current in all radiators.

A further feature resides in the method by which the tuning of the reflector unit can be controlled by a single adjustment, hence making it unnecessary to separately adjust the length of each dipole in the reflector unit in order to obtain proper amplitude and phase of currents therein.

Other objects and features will appear in the subsequent detailed description which is accompanied by drawing, wherein:

Fig. 1 illustrates diagrammatically an antenna arrangement in accordance with the principles of the invention, and

Fig. 2 illustrates a practical embodiment of the antenna of Fig. 1.

Referring to the drawing, there is shown an antenna structure comprising a vertical metallic mast 1 supporting on one side thereof a plurality of parallel horizontal dipoles 2, 2 located in substantially a single vertical plane. Each of the dipoles 2, 2 is approximately one-half wave length long, less possibly a certain end effect, and spaced from its adjacent dipole by a distance also equal to half the length of the communication wave. The dipoles are supported at their center or voltage nodal points by metallic cross braces 3, 3, which are mounted on mast 1.

In order to obtain unidirectional transmission, there are employed on the opposite side of metallic mast 1, an equal number of reflecting dipoles 4, 4 similarly arranged. Dipoles 4, 4 are located in a vertical plane parallel to the vertical plane containing elements 2, 2 and are each one-half wave length long and spaced away from one another by a half wave length. Both planes of dipoles 4, 4 and 2, 2 are spaced apart by a distance about one-quarter wave length, more or less. For example, it has been found that for maximum gain in the forward direction a spacing of about 0.2 wave length is better, while for minimum back radiation without too much sacrifice in forward radiation a spacing between 0.25 and 0.3 wave length is better. The spacing between planes is not a critical factor, and may vary in a range between 0.15 and 0.35 wave length, since there is control of phase of the reflector current by the tuning adjustment of the reflector.

Each dipole 2 is arranged to have a corresponding parallel dipole 4 on the other side of mast 1, located in the same horizontal plane, and similarly suported at its center or voltage node from the same cross brace 3 or an extension thereof.

A two wire transmission line 5 connects dipoles 2, 2 with high frequency apparatus 7 for effecting energization of the antenna. Line 5 connects with the lowermost dipole 2 at spaced points 6 whose impedance therebetween is such as not to offer an unreasonably low resistance load to the line, and is joined to the upper dipoles 2, 2 in similar manner by means of interconnecting wires 7, 7. Wires 7, 7 are arranged to be reversed in position between adjacent dipoles in order to insure proper phasing of the energy in all the dipoles in the same vertical plane; i. e., to provide the same relative polarity in all dipoles. In the arrangement shown in the drawing, the energy in all the dipoles is in phase, or, putting it another way, the dipoles are cophasally excited.

On the opposite side of the metallic mast 1, dipoles 4, 4 are similarly connected together by reversed interconnections 8, 8. These reflecting dipoles are left floating or unenergized, although it will be apparent that, if desired, these may also be energized to obtain a reflecting action.

For tuning the system as a whole to get the maximum directive effect and to obtain a phase adjustment to overcome end effects and minor misadjustments in spacing and the length of the doublets, there is provided a movable extension 9 at the bottom of the reflector comprising a bridging conductor. With such an arrrangement it is not necessary to separately tune the dipoles 2, 2 which automatically adjust themselves for best tuning.

Since the dipole elements 2, 2 and 4, 4 are connected to the center mast 1 at their voltage nodal points, it will be evident that there is little loss or energy transfer from the elements 2, 2 to the mast 1. Consequently there is no need for insulators between either the mast 1 and cross braces 3, or between the cross braces 3 and the dipoles 2, 2. For simplicity in construction and rigidity, it is preferred to use metallic tubes or pipes for the mast, cross pieces and dipoles, and Fig. 2 is a view of a successful practical construction embodying such features.

In this figure, mast 1 is a grounded hollow metallic pipe along whose length are disposed adjustably movable cross braces 3 comprising pipes screwed into circular bands 10, the split ends of which are bolted together at 11. Insulating spacers 12 are provided for keeping the interconnecting wires 7, 7 and 8, 8 separated.

A spacer 13 serves the same purpose for the wires of transmission line 5, only in this case there are employed two parallel bars with the spacer 13 between them to prevent undesired flux leakage between wires.

It will be appreciated that an aerial structure in accordance with this invention can readily be made portable and is relatively easy to erect in high situations such as on the ridges of buildings.

Due to the fact that mast 1 is grounded and each of the dipoles is electrically connected thereto, the antenna is protected against lightning strokes affecting apparatus connected to transmission line 5. If lightning were to directly strike one end of the dipoles 2 the lightning current naturally flows through the dipole and thence to the supporting arm 3 to the metallic supporting mast 1 and thence to ground. The current set up in the transmission line 5 is negligibly small as compared to the current flowing through the supporting structure 1 under such condition. In the case of a lightning stroke near the antenna, since it is well known that the energy in a wave due to a lightning stroke is mostly concentrated over frequencies very much lower than the frequencies for which this invention is particularly adapted, the small horizontal component of the electric field due to the lightning stroke does not set up any substantial current in the dipole at its resonant frequency. Another practical advantage of using a metallic arm to support each of the dipole elements rests in the fact that since there are no insulators between the antenna elements and grounded conductors there is no danger of loss of antenna elements due to insulator breakage by direct lightning strokes.

Although it is preferred to use a spacing of a half wave length between adjacent dipoles in the same vertical plane on each side of the mast, observations have shown that the direction of directivity can be altered by departing somewhat from this half wave length spacing, and consequently the construction is not limited to the use of any such fixed spacing. If desired, a spacing of one wave length can be used between adjacent dipoles in the same vertical plane, and in such case the interconnections between dipoles will not be reversed in position.

One advantage of this invention is that temperature regulation means may be provided within the hollow mast and radiator elements. This means may take any desired form, although it is believed that the use of heating wires inside the tubes for melting off ice is most practical.

If the antenna is employed on high buildings, it is preferred to employ a steel cable running from the top of the antenna to the bottom inside the tubular mast, the cable being secured to the building in order to prevent any possibility of the mast and associated equipment from falling to the street in case of mechanical failure. Such an arrangement is disclosed in copending application Ser. No. 31,184, filed July 13, 1935, by Harold O. Peterson, to which reference is herein made for a more detailed description thereof.

What is claimed is:

1. A directional antenna for use on short waves comprising a vertical metallic mast, a plurality of substantially half wave length horizontal dipoles in a single vertical plane on one side of said mast, extending along the length thereof, said dipoles being separated from one another by substantially a half wave length, another plurality of similar horizontal dipoles in a parallel plane on the other side of said mast, said parallel planes being separated by a distance in the range between 0.15 and 0.35 wave length, each dipole in one of said planes having a corresponding dipole in the other plane in the same horizontal plane, metallic supporting cross braces connecting the centers of said dipoles with said mast, and a pair of wires interconnecting the dipoles located in each vertical plane, said wires being connected to said dipoles at points spaced on both sides of the centers thereof, said wires being reversed in position between adjacent dipoles to effect in-phase energization in said dipoles.

2. A directional antenna for use on short waves comprising a metallic mast, a plurality of substantially half wave length dipoles in a single vertical plane on one side of said mast, extending along the length thereof, said dipoles being separated from one another by substantially a half wave length, another plurality of similar dipoles in a parallel plane on the other side of said mast, said parallel planes being separated by a distance in the range between 0.15 and 0.35 wave length, each dipole in one of said planes having a corresponding dipole in the other plane, metallic supporting cross braces connecting the centers of said dipoles with said mast, and a pair of wires interconnecting the dipoles located in each vertical plane, said wires being connected to said dipoles at points spaced on both sides of the centers thereof, said wires being reversed in position between adjacent dioples to effect in-phase energization in said dipoles, and a transmission line extending to high frequency apparatus connected to one of the dipoles.

3. A directional antenna comprising a vertical metallic supporting mast, a horizontal substantially half wave length dipole on one side of said mast, another parallel horizontal substantially half wave length dipole on the other side of said mast spaced away from said first dipole a distance in the range between 0.15 and 0.35 wave length and arranged in the same horizontal plane, a metallic cross brace joining the centers of said dipoles to said mast, and a two wire transmission line connecting one of said dipoles at points oppositely disposed with respect to its center to high frequency apparatus.

4. A directional antenna comprising a metallic supporting mast, a horizontal substantially half wave length dipole on one side of said mast, another parallel horizontal substantially half wave length dipole on the other side of said mast spaced away from said first dipole a distance in the range between 0.15 and 0.35 wave length and arranged in the same plane, a metallic cross brace joining the centers of said dipoles to said mast, and a two wire transmission line connecting one of said dipoles at points oppo-

sitely disposed with respect to its center to high frequency apparatus.

5. An antenna comprising a vertical metallic supporting mast, a plurality of horizontal dipoles approximately a half wave length each in substantially a single plane on one side of said mast along the length thereof, metallic cross braces joining the centers of said dipoles to said mast, said horizontal dipoles being spaced from one onother by a distance approximately equal to one-half wave length, a pair of wires interconnecting said dipoles, said wires being coupled to said dipoles at points oppositely disposed with respect to the center thereof, and said wires being reversed in position between adjacent dipoles to effect in-phase energization of all said dipoles.

6. An antenna comprising a vertical metallic supporting mast, a plurality of parallel dipoles approximately a half wave length each in substantially a single plane on one side of said mast along the length thereof, metallic cross braces joining the centers of said dipoles to said mast, said parallel dipoles being spaced from one another by a distance approximately equal to one-half wave length, a pair of wires interconnecting said dipoles, said wires being coupled to said dipoles at points oppositely disposed with respect to the center thereof, and said wires being reversed in position between adjacent dipoles to effect in-phase energization of all said dipoles.

7. An antenna in accordance with claim 5, characterized in this, that said mast, cross braces, and dipoles comprise hollow metallic tubes.

8. A directional antenna for use on short waves comprising a metallic supporting mast and a plurality of parallel dipoles in a single plane which is substantially perpendicular to the desired direction of communication on one side of said mast, a similar plurality of dipoles in another plane parallel to said first plane and located on the other side of said mast, said planes being spaced apart a distance in the range between 0.15 and 0.35 wave length, metallic cross braces joining the centers of said dipoles to said masts, a pair of connections in each plane for interconnecting the dipoles therein, a transmission line extending to high frequency apparatus connected to one of said dipoles in one of said planes, and a tuning element associated with the pair of connections in circuit with the dipoles in said other plane for adjusting the phase of the currents in said last dipoles.

9. A directional antenna for use on short waves comprising a plurality of antenna dipoles in a single plane which is substantially perpendicular to the desired direction of communication, a plurality of identical reflector dipoles in a parallel plane spaced away from said first plane, both said antenna and reflector dipoles each consisting of a single straight conductor, a two wire transmission line extending to high frequency apparatus connected to one of said antenna dipoles at points on both sides of the center of said one dipole, and connections from said points to similarly located points on the other antenna dipoles, additional connections similarly coupling the reflecting dipoles together, and a tuning element comprising an adjustable slider connected across the reflector dipole connections for adjusting the phase of the currents therein.

10. A directional antenna comprising a metallic supporting mast, a substantially half wave length dipole on one side of said mast, another parallel substantially half wave length dipole on the other side of said mast spaced away from said first dipole a distance in the range between 0.15 and 0.35 wave length and arranged in the same plane, a metallic cross brace joining the centers of said dipoles to said mast, and a two wire transmission line connecting one of said dipoles at points oppositely disposed with respect to its center to high frequency apparatus.

11. An antenna system comprising two series of horizontal antenna elements each substantially a half wave length long, each antenna element in one series having an element in the other series located substantially in the same horizontal plane, and individual conductors for conductively joining together respectively the elements of the two series which are located in the same horizontal plane, at their center portions.

12. A system in accordance with claim 11, characterized in this that the elements of each series are in a single vertical plane, the planes of both series being different and parallel.

13. An antenna system comprising two series of horizontal antenna elements, each antenna element in one series having an element in the other series located substantially in the same horizontal plane, and means for conductively joining together the elements of the two series which are located in the same horizontal plane, at their voltage nodal points.

14. An antenna system comprising two series of horizontal antenna elements, each antenna element in one series having an element in the other series located substantially in the same horizontal plane, means for conductively joining together the elements of the two series which are located in the same horizontal plane at their voltage nodal points, and a metallic mast conductively joined to said means for supporting said antenna system.

15. An antenna comprising a series of parallel antenna elements substantially in the same plane, each of said antenna elements having a voltage nodal point at the frequency of the operating wave, a metallic mast at relatively zero radio frequency potential, and means fixing said elements to said mast at said voltage nodal points.

16. A directional antenna comprising a metallic supporting mast, a substantially half wave length dipole on one side of said mast, another parallel substantially half wave length dipole on the other side of said mast spaced away from said first dipole a distance in the range between 0.15 and 0.35 wave length and arranged in the same plane, means joining the centers of said dipoles to said mast, and a two wire transmission line connecting one of said dipoles at points oppositely disposed with respect to its center to high frequency apparatus.

17. A directional antenna comprising a metallic supporting mast, a substantially half wave length dipole on one side of said mast, means mechanically and electrically securing said dipole to said mast at a voltage nodal point on said dipole, and a connection from said mast to ground, whereby lightning surges striking said dipole are by-passed to ground and have substantially no effect on the flow of radio frequency currents therein.

18. A directional antenna comprising a metallic supporting mast, a substantially half wave length dipole on one side of said mast, means mechanically and electrically securing said di-

pole to said mast at a voltage nodal point on said dipole, a two-wire transmission line connecting said dipole at points oppositely disposed with respect to its center to high frequency translating apparatus, and a connection from said mast to ground, whereby lightning surges striking said dipole are by-passed to ground and have substantially no effect on the flow of radio frequency currents therein.

19. An all metal antenna comprising a series of parallel antenna elements substantially in the same plane, each of said antenna elements having a voltage nodal point at its center for the frequency of the operating wave, a grounded metallic mast, and electrically conducting means mechanically and electrically securing said elements at said centers to said mast.

PHILIP S. CARTER.