May 24, 1949. H. SELVIDGE 2,471,045

ULTRA HIGH FREQUENCY ANTENNA SYSTEM

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Fig. 1.

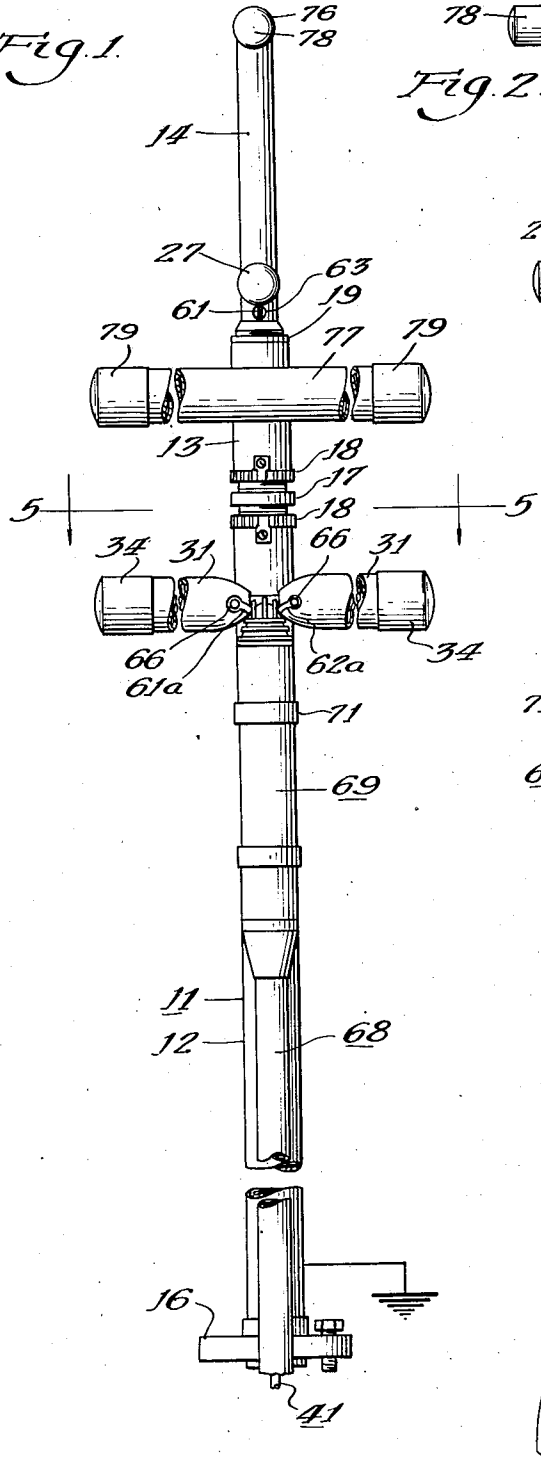
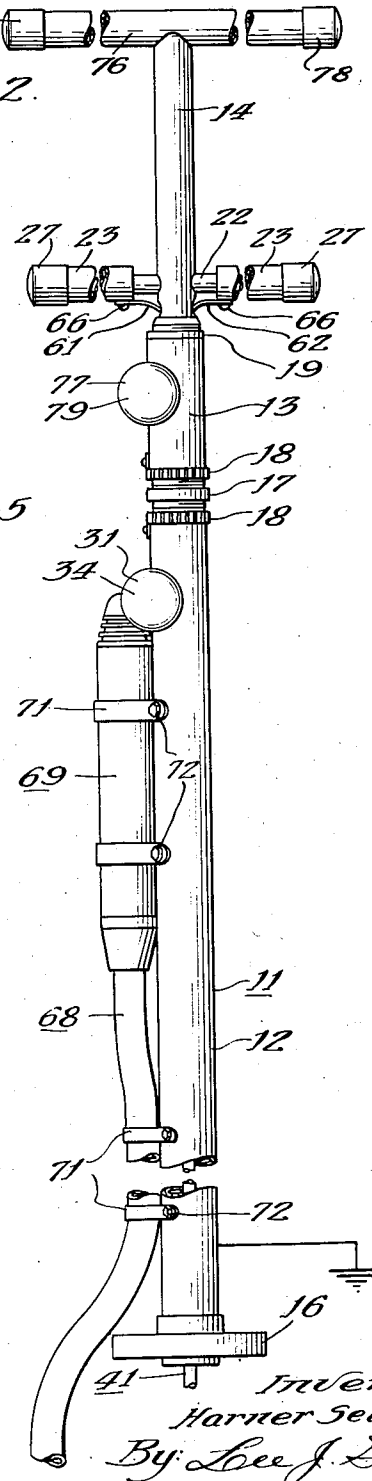


Fig. 2.



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Fig. 3.

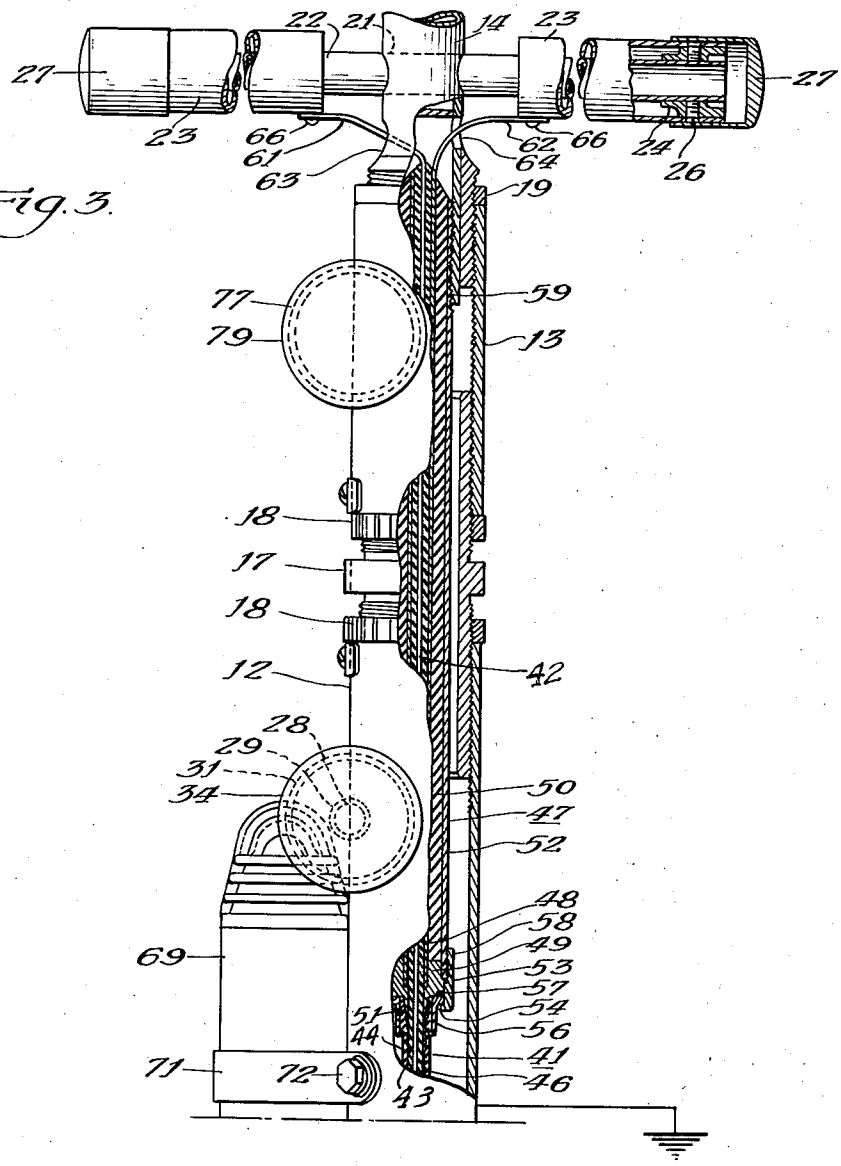
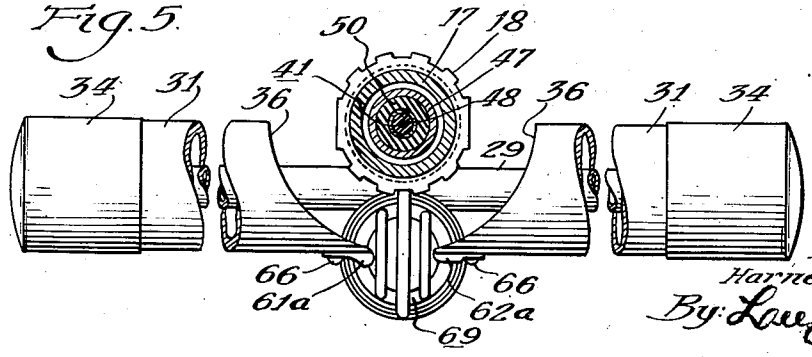


Fig. 5.



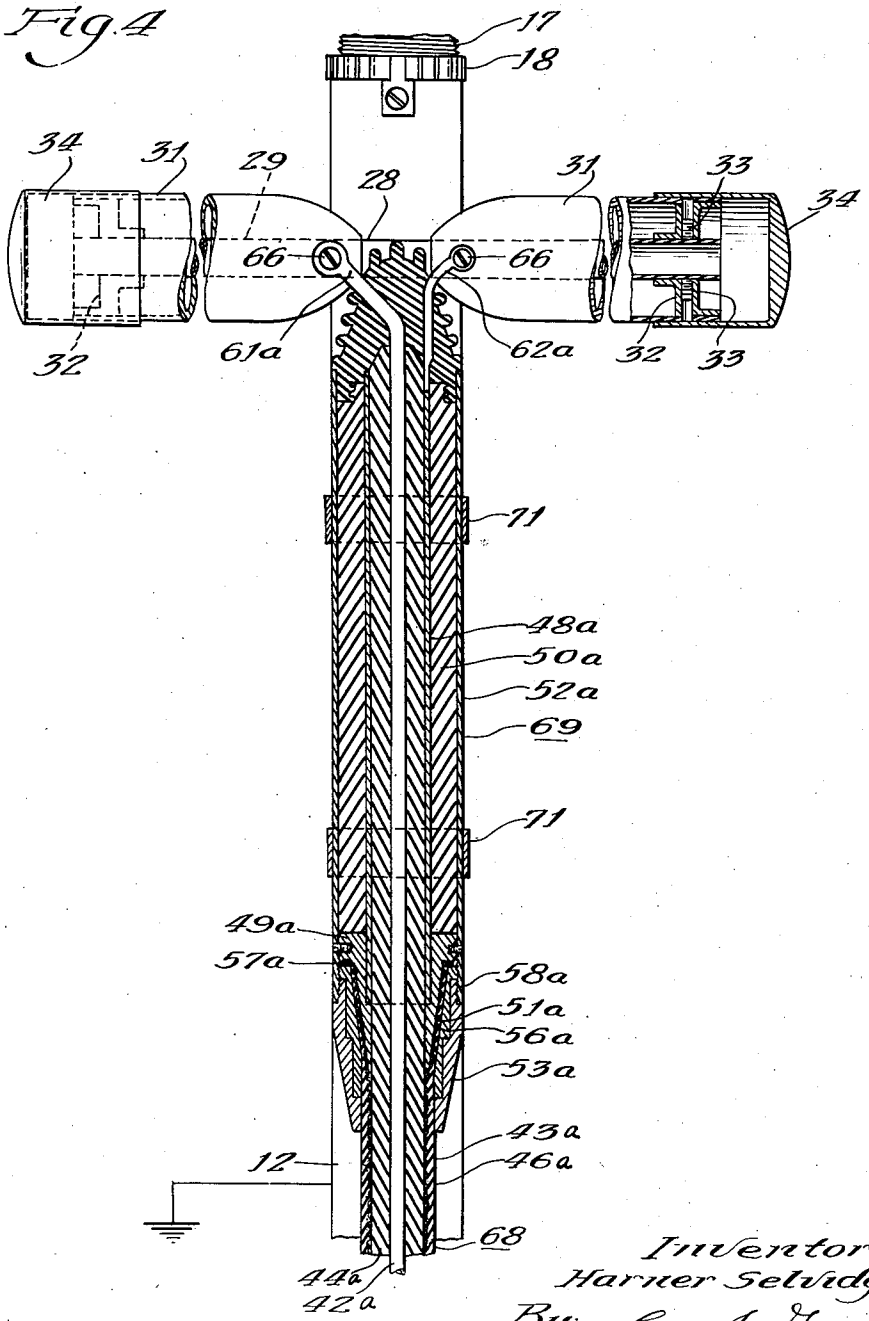
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ULTRA HIGH FREQUENCY ANTENNA SYSTEM

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Fig. 4



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UNITED STATES PATENT OFFICE

2,471,045

ULTRA HIGH FREQUENCY ANTENNA SYSTEM

Harner Selvidge, Silver Spring, Md.

Application October 21, 1944, Serial No. 559,670

11 Claims. (Cl. 250—33.57)

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This invention relates to improvements in ultra high frequency antenna systems of the type adapted for use in broadcasting, communications, television, radar, etc., and has for an object the provision of an antenna system which is relatively simple and inexpensive in construction and having improved operating characteristics.

It is a further object of this invention to provide an antenna system in which radiation from parts of the structure other than those intended for this purpose is prevented in order to preserve the desired uniform radiation pattern, and to also thereby increase the efficiency of the system and to reduce the power loss.

Another object of this invention is to provide a dipole antenna construction embodying a pair of half wave antennas supported in spaced relation and at right angles to each other on a vertically or horizontally disposed mast. Each half wave antenna comprises a supporting conductor and a pair of quarter wave length radiator elements mounted thereon and short circuited thereto at their ends. A transmission line comprising a pair of coaxially disposed conductors having a solid dielectric disposed therebetween is employed to transmit radio frequency energy to a line balance converter which is connected to the inner ends of the quarter wave length radiator elements of each antenna. Due to the electrical and mechanical symmetry of the arrangement of parts forming the antenna system, each quarter wave radiator element is electrically balanced with respect to the grounded conductor shield of the line balance converter and transmission line and any currents which may be induced in the shield by radiation are equal and opposite and thus cancelled. It will, therefore, be seen that the system provides symmetrical radiation from the quarter wave length radiator elements, and that there is no net induced current in the shielding even though it be in the field of the antenna as the currents induced by the two radiator elements of each half wave length antenna are equal and opposite and thus cancelled.

Heretofore, for example, some half wave length horizontally polarized antennas have been directly fed and connected intermediate their ends by means of a vertically disposed, coaxial, unbalanced type of transmission line in which the outside shield is grounded. In this type of system the individual impedances of the quarter wave length radiator elements are not uniform with respect to nearby grounded conductors and cause induced currents in them which fail to cancel, and the net current flowing in them results in

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radiation of energy therefrom. As any radiation from vertically polarized nearby grounded conductors would not be picked up on horizontally disposed antennas, it results in a loss of energy. Due to this lack of symmetry, unequal currents flow in the quarter wave length radiators and results in a loss of symmetry of the resulting radiation pattern of the antenna.

It is a further object of this invention to provide an antenna system embodying line balance converters which provide a balanced feeding system for the quarter wave radiator elements of each half wave antenna. In order to preserve the desired radiation pattern, the conductors leading from each line balance converter to their respective quarter wave length radiator elements are relatively short and disposed in the most advantageous manner. By providing each line balance converter with a solid dielectric filling and insulation, the converter embodies the same characteristics and advantages as a coaxial transmission line cable embodying a solid dielectric. Line balance converters have heretofore been provided with dried nitrogen or dried air under pressure as the dielectric, and they are, therefore, subject to variations in characteristics caused by condensation of moisture therein in the event of leakage within the system, and further necessitate the use of elaborate pressure and dehumidifying devices for maintaining the dielectric in a dry state. By forming the line balance converter with a solid dielectric, it is also possible to use a flexible type of coaxial cable in place of the rigid type of transmission lines heretofore employed with gas filled, line balance converters.

It is a further object of this invention to provide an antenna construction in which center conductors are metallically supported in spaced relation on a tubular metal mast for supporting pairs of radiator elements at their ends. The center conductors and radiator elements are short-circuited at their outer ends by means of adapters disposed therebetween. The radiator elements are adjustably spaced with respect to the mast and each other and connected at their inner ends to their respective conductors leading from the line balance converter. Due to the high impedence of the inner ends of the radiator elements with respect to the adjacent portions of their center conductors, it is possible to metallically connect the center conductors to the tubular metal mast which will be at ground potential. Metallic caps are provided to enclose the outer ends of the radiator elements, and to provide an adjustment for the radiation length.

It is a further object of this invention to provide an antenna construction in which a half wave length antenna and reflector are metallically supported in adjustable spaced relation to each other upon a tubular metallic mast.

In a dual antenna system mounted on a single mast, radio frequency energy is fed to the upper antenna by means of a semi-flexible, coaxial transmission line cable centrally disposed within the mast, and the lower antenna is metallically connected to and supported upon the outer wall of the mast and fed with radio frequency energy by means of another semi-flexible, coaxial transmission line cable located outside the mast. By means of this arrangement of antennas and transmission line cables, relatively short conductors may be provided between the quarter wave length radiator elements and their respective line balance converters.

It is a further object of this invention to provide a tubular metallic mast embodying coupling means for positioning the antennas and reflectors in alignment with each other in order to form an assembly adapted for packaging, shipping, and storage.

The line balance converter hereinafter shown and described in this application forms the subject matter of a copending application, Serial No. 559,671, executed and filed concurrently herewith, now abandoned.

This invention embodies other novel features, details of construction and arrangement of parts which are hereinafter set forth in the specification and claims, and illustrated in the accompanying drawings wherein:

Fig. 1 is a front elevational view showing an antenna system embodying the features of this invention.

Fig. 2 is a side elevational view of same.

Fig. 3 is an enlarged fragmentary view, partly in section, showing a line balance converter disposed within the tubular mast and connected to an upper set of quarter wave length radiator elements of the upper half wave length antenna.

Fig. 4 is an enlarged fragmentary view, partly in section, showing a modified form of a line balance converter and the method of connecting same at its one end to a semi-flexible, coaxial conductor cable, and at its other end to a pair of quarter wave length radiator elements of the lower half wave length antenna.

Fig. 5 is an enlarged sectional view taken along the line 5—5 of Fig. 1.

Referring now to the drawings for a better understanding of this invention, the antenna system is shown as comprising a supporting mast 11 formed of three detachably connected sections of tubular metal indicated at 12, 13, and 14. The lower section 12 of the mast is welded at its lower end to a supporting flange 16, and is internally threaded at its upper end for threaded engagement with one end of an externally threaded adjustment nipple 17. The intermediate section 13 of the mast is internally threaded at its ends to receive at its one end the externally threaded nipple 17 and at its upper end an externally threaded portion provided on the upper section 14 of the mast. One end of the nipple 17 is formed with right hand threads and the other end of the nipple is formed with left hand threads in order that the sections 12 and 13 may be adjustably moved towards, or away, from each other by rotational movement of the nipple. The nipple 17 and mast sections 12 and 13 are secured in assembled position by means of lock nuts 18. The upper section 14 of the mast is secured against relative movement with respect to the mast section 13 by means of a lock nut 19.

The upper section 14 of the mast is provided with transversely extending aligning apertures 21 to receive a metallic, tubular, radiator element supporting conductor 22. The conductor 22 is brazed to the walls of the apertures 21, and has its ends equidistantly spaced from the axis of the mast to support a pair of radiator elements 23 formed of tubular metal and copper plated. The radiator elements 23 are connected on the ends of the supporting conductor 22 by means of metallic adapters 24 which snugly engage the inner wall of the radiator elements and are bored to receive the ends of the supporting conductors 22. The radiator elements are preferably approximately one quarter wave in length and electrically connected to form a half wave length antenna. The radiator elements are adjustable axially on the supporting member 22 by means of set screws 26 which pass through apertures provided through the walls of the radiator elements for threaded engagement with the adapters 24 and locking engagement against the supporting conductor 22. The adapters 24 are formed of metal to form a short-circuit between the outer ends of the radiator elements and the supporting conductor, and are brazed at their outer ends to the outer ends of their respective radiator elements. A metallic cap 27 is provided to snugly engage and enclose the open end of each radiator element and extends inwardly a sufficient distance thereover to cover the apertures provided for the set screws 26.

A transversely extending arcuate groove 28 is formed in the outer wall of the lower section 12 of the mast to receive a radiator element supporting conductor 29 which is brazed thereto at a point intermediate its ends. Quarter wave radiator elements 31 are supported at their outer ends upon the outer ends of the supporting conductor 29 by means of spacing adapters 32. The adapters 32 are formed of metal and brazed to their respective radiator elements 31 to form a short-circuit between the ends of the radiator elements and the ends of their supporting conductor. The radiator elements are adjustably positioned axially on the supporting conductor by means of set screws 33. A metallic cap 34 is provided to snugly engage and enclose the outer end of each radiator element and to cover the apertures provided therein for the set screws 33. The inner ends of the radiator elements 31 are formed arcuate at 36, as viewed in Fig. 5, and it will be observed that the axis of the arc is disposed at the axis of the mast to provide a uniform spacing therebetween. The radiator elements 31 are one quarter wave length and are connected to form a half wave antenna.

A transmission line 41 is employed to feed radio frequency energy to the radiator elements 23 comprising the upper antenna. This transmission line is of the semi-flexible, coaxial conductor type in which an inner conductor 42 and an outer conductor 43 are disposed in concentric relation by means of a solid dielectric insulation 44, the outer conductor 43 being formed of braided wire and covered by a vinyl jacket 46.

The end of the transmission line leads to a line balance converter 47, and is connected thereto by stripping the braided wire conductor 43 and vinyl jacket 46 from the end of the transmission line to receive a metallic, tubular conductor shell 48 of quarter wave length. This metallic shell

48 is adapted to snugly engage the dielectric insulation 44 of the cable. A metallic spacing collar 49 is brazed to the end of the shell 48, and is formed with a tapered shoulder 51 for engagement under the braided outer conductor 43. A metallic tubular shield 52 has its one end mounted on the spacing collar 49 and is secured thereto by means of a clamping nut 53. The clamping nut is formed with an inwardly disposed annular flange 54 for engagement with an outwardly disposed flange provided on a clamping ring 56. A gasket 57 is provided between collar 49 and the clamping ring 56. By means of the threaded engagement at 58 between the shield 52 and clamping nut 53, the shield 52 and outer conductor 43 are firmly secured to the annular collar 49 and provide a leak-proof connection between the cable 41 and the line balance converter. The space between the metallic shell 48 and the metallic shield 52 is filled with a suitable solid dielectric insulation 50 such as polythylene or preferably with insulation having physical and electrical properties similar to the cable dielectric 44. The upper end of the metallic shield 52 is externally threaded for engagement at 59 with internal threads formed on the inner wall of the upper mast section 14. A pair of terminals 61 and 62 extend upwardly from their respective conductors 42 and 43, and diverge outwardly to pass through apertures 63 and 64 respectively, formed in the wall of the mast section 14. The ends of the terminals 61 and 62 are connected to the inner ends of their respective radiator elements 23 by means of terminal screws 66.

The line balance converter 47 provides a balanced feeding system before connection is made with the inner ends of the antenna radiator elements 23. By providing a quarter wave shield 52 over the end of the coaxial transmission line and then short-circuiting the shield to the outer conductor 43 of the transmission line by means of the metallic spacing collar 49, two coaxial transmission lines provided, one consisting of the center conductor 42 and conductor shell 48. Coaxial therewith is a second transmission line in which the center conductor is the tubular shell 48 plus the shield 52 of the line balance converter. As the center conductor 42 always has a high impedence with respect to its outer conductor or shield 43, there is also a high impedence from the conductor 42 to the conductor shell 48. Since the line balance converter consists of a quarter wave length transmission line short-circuited at its point of connection with the cable, there is a high impedence between the shield 52 and conductor shell 48. Thus, the terminal ends of the conductor 42 and conductor 48 both have a high impedence with respect to ground, and a balanced transmission line or antenna may be attached at these points. The line balance converter thus serves to keep the two halves of the upper antenna in perfect balance and to give exact symmetry to the resulting radiated field. The line balance converter further reduces losses resulting from spurious induced currents (in nearby grounded objects) which exist when unbalanced feeding systems are used.

The lower antenna is provided with a semi-flexible transmission line 68 and a line balance converter 69 which are secured to the outer surface of the mast by means of metallic bands 71 and screws 72. The transmission line 68 and line balance converter 69 are similar in construction and operation to the transmission line 41 and line balance converter 47 heretofore described. It will be noted, however, that the line balance converters 47 and 69 are suitably positioned with respect to their radiator elements 23 and 31, respectively, to permit the use of relatively short terminal conductors 61 and 62 and so arranged as not to appreciably interfere with the symmetry of the radiated field.

A dipole reflector 76 is brazed at its center to the upper end of the mast section 14 and disposed in parallel, vertical alignment with the upper half wave antenna. A reflector 77 is brazed to the side of the mast section 13 and disposed in parallel, vertical alignment with the lower antenna. The reflectors 76 and 77 are preferably formed of metal tubing and provided with suitable caps 78 and 79, respectively, for snug telescopic engagement over the ends of the reflectors.

While this invention has been shown in but one form, it is obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit and scope of the claimed invention.

I claim as my invention:

1. In an antenna system, a supporting conductor, a pair of hollow radiator elements coaxially supported at their outer ends on said supporting conductor, a mast for engagement with said supporting conductor between said radiator elements, and means providing a balanced transmission line for connection to the inner ends of said radiator elements for maintaining same in substantially perfect balance to provide substantially exact symmetry to the resulting radiated field.

2. In an antenna system, a supporting conductor, a pair of hollow radiator elements coaxially supported at their outer ends by said supporting conductor, a mast for engagement with said supporting conductor between said radiator elements, a semi-flexible transmission line having coaxial conductors and a solid dielectric insulation for feeding radio frequency energy to the inner ends of said radiator elements, and means for substantially balancing said transmission line at its radiator terminal end to provide substantial symmetry to the resulting radiated field.

3. In an antenna system, a metallic supporting conductor, a pair of hollow radiator elements coaxially supported at their outer ends by said supporting conductor, a hollow metallic mast connected to said supporting conductor between said radiator elements, and a line balance converter disposed within said hollow mast and having relatively short diverging terminal conductors extending outwardly from the mast opposite the inner ends of the radiator elements for connection therewith for maintaining said radiator elements in substantial balance.

4. In an antenna system, a supporting conductor, a pair of hollow radiator elements coaxially supported at their outer ends on said supporting conductor, a mast for engagement with said supporting conductor between said radiator elements, and means providing a balanced transmission line for connection to the inner ends of said radiator elements for maintaining same in perfect balance to provide exact symmetry to the resulting radiated field, and cap means for adjusting the radiation length of said radiator elements.

5. In an antenna system, a metallic supporting conductor, a pair of hollow radiator elements coaxially supported at their outer ends by said supporting conductor, a mast, means for metallically connecting the central portion of said sup-

porting conductor to the side of said mast and at right angles to the axis thereof, and a balanced transmission line disposed along the side of said mast and having conductors terminating at the inner ends of said radiator elements.

6. In an antenna system, a metallic supporting conductor, a pair of hollow radiator elements coaxially supported at their outer ends by said supporting conductor, a mast, means for metallically connecting the central portion of said supporting conductor to the side of said mast and at right angles to the axis thereof, and a line balance converter secured to the side of said mast and having conductors terminating at the inner ends of said radiator elements.

7. In an antenna system, a metallic supporting conductor, a pair of hollow radiator elements coaxially supported at their outer ends by said supporting conductor, a mast, means for metallically connecting the central portion of said supporting conductor to the side of said mast and at right angles to the axis thereof, and a line balance converter secured to the side of said mast and having conductors terminating at the inner ends of said radiator elements, the inner ends of said radiator elements conforming with the contour of said mast to decrease the length of the terminal conductors leading thereto.

8. In a dual antenna system, a hollow mast formed by three connecter coaxial sections, a dipole reflector centrally supported at the top of the upper mast section, a balanced dipole antenna secured to the lower end of the upper mast section, a coaxial transmission line having the balanced output disposed within the mast for feeding radio frequency energy to the center of said dipole antenna, a second dipole reflector secured to the side of the intermediate mast section, a second dipole antenna secured to the side of the lower mast section, and a second balanced coaxial transmission line disposed along the outer side of the mast for feeding radio frequency energy to the center of said second dipole antenna.

9. In a dual antenna system, a hollow mast formed by three connected coaxial sections, a dipole reflector centrally supported at the top of the upper mast section, a balanced dipole antenna secured to the lower end of the upper mast section, a coaxial transmission line having the balanced output disposed within the mast for feeding radio frequency energy to the center of said dipole antenna, a second dipole reflector secured to the side of the intermediate mast section, a second dipole antenna secured to the side of the lower mast section, a second balanced coaxial transmission line disposed along the outer side of the mast for feeding radio frequency energy to the center of said second dipole antenna, and means for rotatably and axially adjusting the mast sections.

10. In an antenna system, a metallic supporting conductor, a pair of hollow radiator elements coaxially supported at their outer ends by said supporting conductor, a hollow metallic mast connected to said supporting conductor between said radiator elements, and a line balance converter disposed within said hollow mast and having relatively short diverging terminal conductors extending outwardly from the mast opposite the inner ends of the radiator elements for connection therewith, said line balance converter being filled with a solid dielectric insulation.

11. In an antenna system, a metallic supporting conductor, a pair of hollow radiator elements coaxially supported at their outer ends by said supporting conductor, a mast, means for metallically connecting the central portion of said supporting conductor to the side of said mast and at right angles to the axis thereof, and a line balance converter secured to the side of said mast and having conductors terminating at the inner ends of said radiator elements, said line balance converter being filled with a solid dielectric insulation.

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