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ANTENNA SYSTEM

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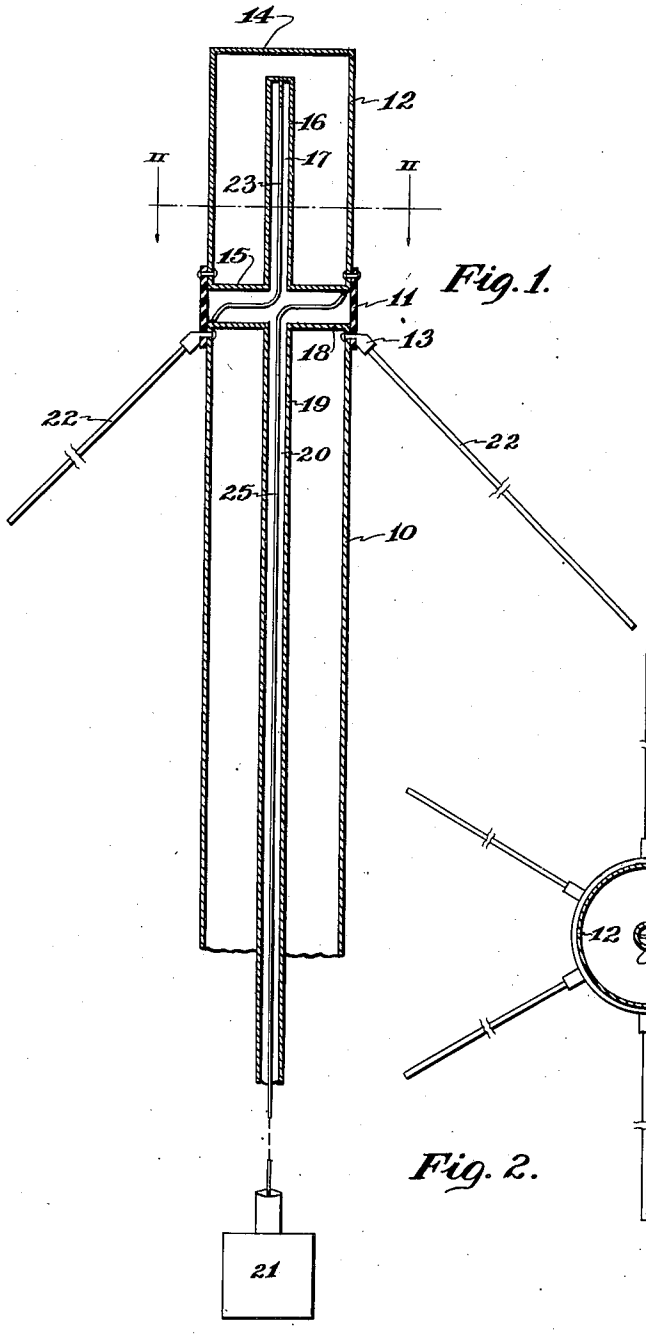

Fig. 1.

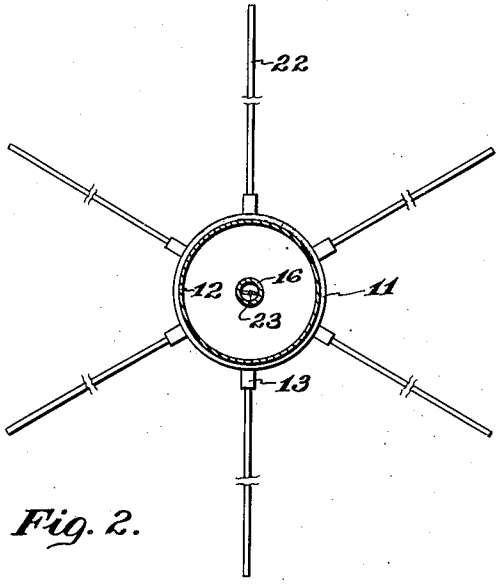

Fig. 2.

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ANTENNA SYSTEM

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13 Claims. (Cl. 250—33)

1

This invention relates to antenna systems, and more particularly to wide-band antennae for use at high radio frequencies.

Recent developments in the art of high frequency radio communication have produced a need for an antenna, which is operative over a comparatively wide band.

Conventional antennae of this type comprise a vertical radiator, one quarter wave in length at the mean operating frequency, in conjunction with a radial structure, which serves as a ground plane mounted at the base of the radiator. In its simplest form an antenna of this description is intended to be supplied with high frequency electrical energy at a point between the base of the radiator and the ground plane. Its impedance is usually too low for use directly with commercially available transmission lines. Auxiliary impedance matching means must be connected, which render the apparatus more frequency critical, and such antennae are therefore not very advantageous.

Broadening of the pass band is usually achieved by increasing the diameter of the vertical radiator and the cross-sectional area of the base structure. The practical and economical disadvantages of such an arrangement are obvious.

The conventional design requires, moreover, compensation for the phase angle of the antenna at frequencies slightly removed from the natural resonant frequency. For that purpose, a parallel circuit, resonant at the mean frequency of the desired pass band, has been connected to the end of the transmission line at the antenna. Such a circuit is, however, subject to changes due to mechanical and thermal effects. Its value for high quality apparatus is therefore questionable.

Prior art wide-band antennae, finally, have comprised a plurality of irregular geometrical configurations which have offered considerable difficulty in fabrication.

One of the objects of the invention is to provide a novel wide-band antenna system of simple mechanical design and of pleasing appearance, suitable for use on the tops of high buildings and towers.

Another object of the invention is to provide a novel antenna system which presents the proper impedance to the transmission line.

A further object of the invention is to provide a novel antenna system of simple design whose pass band is sufficiently wide to meet all requirements of present-day high frequency transmission and reception.

Still another object of the invention is to provide a novel antenna system consisting of a combination of a conical and straight antenna which secures a band pass of considerable width.

A still further object of the invention is to provide novel means to compensate for the phase

2

angle of the antenna at frequencies slightly removed from its natural frequency.

The above and other objects and advantages of my invention are accomplished by means of a metallic cylindrical radiator of a length of approximately one-quarter wave length at the mean operating frequency containing within itself an impedance matching line element of a length substantially less than a quarter wave length, a plurality of metallic rod radiating members arranged as elements of a conical surface whose apex points toward said cylinder together with means for increasing the electrical capacity between said cylinder and said conical formation of rod members for the purpose of compensating for the deficiency in length of the impedance matching element.

With these and other objects in view, the invention consists of certain novel details of construction and combinations of parts, hereinafter fully described and claimed, it being understood that various modifications may be resorted to within the scope of the appended claims without departing from the spirit or sacrificing any of the advantages of the invention.

Other objects and advantages of the invention will in part be disclosed and in part be obvious, when the following specification is read in conjunction with the drawings, in which

Figure 1 is a longitudinal section of the antenna system of my invention in elevation, and

Figure 2 is a cross sectional plan view of the invention taken along the line II—II of Figure 1.

Referring now to the drawings, the numeral 10 denotes a suitable mast or support which may be of any material, conductive or non-conductive, but which is here shown, for purposes of illustration, as a hollow metallic cylinder. Supported upon the upper end of mast 10 and collinear therewith, by means of the encircling insulating collar 11, is a cylinder of conductive material 12 of a length of substantially one-quarter of a wave length at the mean operating frequency. Suitable bolts, rivets or the like, 13, may be made use of to rigidly join members 10, 11 and 12 together. The upper end of cylinder 12 may be closed, if desired, by the protective plate 14 which may be of either conductive or non-conductive material.

The lower end of cylinder 12 is closed by plate 15, of conductive material having formed therein at its center, an aperture into which is fastened by soldering, or other suitable means, the outer shield 16 of a co-axial line 17.

The upper end of mast 10 is closed by plate 18, of conductive material, having formed therein, at its center, an aperture into which is fastened by soldering, or other suitable means, the outer shield 19 of a co-axial feed line 20, connected at its other end to a suitable transmitter or receiver 21.

Suitably attached to plate 18, as by engagement with the heads of the fastening members 13, and symmetrically arranged about the periphery of plate 18, are the rod members 22, each approximately of a length of one-half wavelength at the mean operating frequency, and forming an element of a conical surface whose axis coincides with the axis of cylinder 12 and whose apex points toward said cylinder. By experiment it has been determined that optimum results are obtained with this antenna system when the angle between the rod members 22 and the axis of the cylinder 12 is of the order of forty-five degrees. This system of rods 22 forms the substantial electrical equivalent of a conical radiator but the rod structure is preferred due to its lighter weight and lessened wind resistance.

The inner conductor 23 of the co-axial line 17 is connected at its upper end to the outer shield thereof, 16, by means of a shorting plate, and the lower end of conductor 23 is connected to plate 18. The inner conductor 25 of the co-axial feed line 20 is connected at its distal end to the receiver or transmitter 21 and at its proximal end to the plate 15.

It will thus be seen that the antenna system of the present invention comprises essentially a half-wave dipole antenna in which one section is cylindrical and the other conical, together with a parallel resonant line bridged across the adjacent ends of the two sections and capacitative members in shunt with the resonant line to compensate for its deficiency in length.

It will be obvious that many changes and modifications may be made in the arrangement and proportioning of the various dimensions without departing from the spirit of the invention as described in the foregoing description and defined in the appended claims.

What is claimed is:

1. A wide band antenna comprising a cylindrical member and a frusto-conical member having its smaller end adjacent one end of the cylindrical member whereby a substantial amount of electrical capacity is created therebetween, a shorted line of a length less than a quarter wavelength connected in shunt with the adjacent ends of the cylindrical member and the frusto-conical member, the electrical capacity between the ends of the two members serving to compensate for the deficiency in length of the line, and means for connecting the members to a radio receiver or transmitter.

2. A wide band antenna comprising a conductive hollow cylinder, a conductive plate closing one end of said cylinder, a second co-acting plate spaced from the first plate, a section of co-axial line shorted at one end and of a length substantially less than a quarter of a wavelength positioned within said cylinder and bridged across said plates, and a plurality of conductors each forming an element of a conical surface co-axial with said cylinder and having its apex pointed toward said cylinder, each of said conductors being joined to the periphery of the second mentioned plate.

3. A wide band antenna comprising a first and second conductive cylinder positioned in collinear end-to-end relation and electrically insulated from each other, a co-axial feed line bridged across the adjacent ends of said cylinders, a quarter-wave resonant co-axial line section also bridged across the adjacent ends of said cylinders, and a counterpoise array symmetrically disposed about and joined to one of said cylinders.

4. A wide band antenna comprising a first and a second conductive cylinder positioned in collinear end-to-end relation and electrically insulated from each other, a section of co-axial line positioned within the first cylinder and having its inner and outer conductors electrically connected together at one end, the other end of the outer conductor of said co-axial line being electrically connected to the inner end of the first cylinder and the inner conductor of said co-axial line being electrically connected to the inner end of the second cylinder, a second co-axial line, joined at one end to a suitable radio frequency device, entering and partially contained within the second cylinder and having its outer conductor electrically connected to the inner end of the second cylinder and its inner conductor electrically connected to the inner end of the first cylinder, and a plurality of conductors symmetrically arranged around and joined to the second cylinder at its inner end, said last named conductors forming equal acute angles with the axis of the first cylinder.

5. A wide band antenna comprising a first and a second conductive cylinder positioned in collinear end-to-end relation and electrically insulated from each other, a section of co-axial line positioned within the first cylinder and having its inner and outer conductors electrically connected together at one end, the other end of the outer conductor of said co-axial line being electrically connected to the inner end of the first cylinder and the inner conductor of said co-axial line being electrically connected to the inner end of the second cylinder, a second co-axial line, joined at one end to a suitable radio frequency device, entering and partially contained within the second cylinder and having its outer conductor electrically connected to the inner end of the second cylinder and its inner conductor electrically connected to the inner end of the first cylinder, and a plurality of conductors symmetrically arranged around and joined to the second cylinder at its inner end, said last named conductors forming equal angles of the order of forty-five degrees with the axis of the first cylinder.

6. A wide band high frequency antenna comprising, in combination, an upper and a lower conductive cylinder positioned in collinear end-to-end relationship and electrically separated one from the other, a section of co-axial line positioned within the upper of said cylinders and having its inner and outer conductors electrically connected together at one end so as to form a parallel resonant circuit at the mean operating frequency, the other end of the outer conductor of said co-axial line being electrically connected to the lower end of said upper cylinder while the corresponding end of the inner conductor is electrically connected to the upper end of the lower cylinder, a second co-axial line joined at one end to a radio frequency device and entering said lower cylinder at the lower end thereof and terminating at a point near the adjacent ends of said cylinders, the outer conductor of said second co-axial line being electrically connected to the upper end of the lower cylinder while the inner conductor thereof is electrically connected to the lower end of said upper cylinder, and a plurality of symmetrically arranged conductors each joined to points on and around the upper end of the lower cylinder and extending downwardly and outwardly therefrom and forming acute angles with the axis of the cylinders.

7. A wide band high frequency antenna comprising, in combination, an upper and a lower conductive cylinder positioned in collinear end-to-end relationship and electrically separated one from the other, a section of co-axial line positioned within the upper of said cylinders and having its inner and outer conductors electrically connected together at one end so as to form a parallel resonant circuit at the mean operating frequency, the other end of the outer conductor of said co-axial line being electrically connected to the lower end of said upper cylinder while the corresponding end of the inner conductor is electrically connected to the upper end of the lower cylinder, a second co-axial line joined at one end to a radio frequency device and entering said lower cylinder at the lower end thereof and terminating at a point near the adjacent ends of said cylinders, the outer conductor of said second co-axial line being electrically connected to the upper end of the lower cylinder while the inner conductor thereof is electrically connected to the lower end of said upper cylinder, and a plurality of symmetrically arranged conductors each joined to points on and around the upper end of the lower cylinder and extending downwardly and outwardly therefrom and forming angles of substantially forty-five degrees with the axis of the cylinders.

8. An antenna system adapted to radiate or receive a band of high radio frequencies comprising a pair of hollow collinear conductive cylinders comprising a mast cylinder and an upper cylinder positioned in end-to-end relationship, the upper cylinder being of a length substantially equal to a quarter-wave length at the mean operating frequency, a sleeve of insulating material mechanically joining but electrically insulating the adjacent ends of said cylinder, a section of co-axial line of a length substantially less than one quarter wave length positioned within said upper cylinder and lying along the axis thereof, said co-axial line having its inner and outer conductors electrically joined together at their upper ends and having the lower end of its outer conductor electrically connected to the lower end of the upper cylinder and the lower end of its inner conductor electrically connected to the upper end of the mast cylinder, a co-axial feed line having one end suitably connected to a radio transmitter or receiver and the other end positioned co-axially within the mast cylinder and having the adjacent end of its outer conductor electrically connected to the upper end of the mast cylinder and the adjacent end of its inner conductor electrically connected to the lower end of the upper cylinder, two spaced circular conductive plates closing the adjacent ends of the upper cylinder and the mast cylinder and serving to compensate, by reason of their mutual capacity for the deficiency in length of the first mentioned co-axial line, and a plurality of conductive rods joined to the outer surface of the mast cylinder at a point adjacent its upper end and extending downwardly and outwardly therefrom, each rod forming with the axis of the cylinders an equal acute angle.

9. An antenna system adapted to radiate or receive a band of high radio frequencies comprising a pair of hollow collinear conductive cylinders comprising a mast cylinder and an upper cylinder positioned in end-to-end relationship, the upper cylinder being of a length substantially equal to a quarter-wave length at the mean operating frequency, a sleeve of insulating material mechanically joining but electrically insulating the adjacent ends of said cylinders, a section of co-axial line of a length substantially less than one quarter wave length positioned within said upper cylinder and lying along the axis thereof, said co-axial line having its inner and outer conductors electrically joined together at their upper ends and having the lower end of its outer conductor electrically connected to the lower end of the upper cylinder and the lower end of its inner conductor electrically connected to the upper end of the mast cylinder, a co-axial feed line having one end suitably connected to a radio transmitter or receiver and the other end positioned co-axially within the mast cylinder and having the adjacent end of its outer conductor electrically connected to the upper end of the mast cylinder and the adjacent end of its inner conductor electrically connected to the lower end of the upper cylinder, two spaced circular conductive plates closing the adjacent ends of the upper cylinder and the mast cylinder and serving to compensate, by reason of their mutual capacity, for the deficiency in length of the first mentioned co-axial line, and a plurality of conductive rods joined to the outer surface of the mast cylinder at a point adjacent its upper end and extending downwardly and outwardly therefrom, each rod forming with the axis of the cylinders an angle of substantially forty-five degrees.

10. In an antenna system, two collinear metallic cylinders, an insulating collar between them, a co-axial feed line and a co-axial short-circuited transmission line of predetermined length, each of said lines being mounted in a respective one of said cylinders, the outer conductor of each line being connected to the inner conductor of the other line and to the cylinder in which it is mounted.

11. A wide band antenna as claimed in claim 3, said counterpoise array comprising a plurality of rods one half wavelength in length at the mean operating frequency of said antenna, said rods extending along and diverging from said one of said cylinders.

12. A wide band antenna as claimed in claim 3, said counterpoise array comprising a plurality of rods one half wavelength in length at the mean operating frequency of said antenna, each of said rods forming an element of the surface of a frustum of a cone coaxial with said one of said cylinders, each of said rods being joined at one end to the periphery of said one of said cylinders.

13. In an antenna system, two collinear metallic cylinders, an insulating collar between them, a co-axial feed line and a co-axial short-circuited transmission line of predetermined length, each of said lines being mounted in a respective one of said cylinders, the outer conductor of each line being connected to the inner conductor of the other line and to the cylinder in which it is mounted, and a counterpoise array symmetrically disposed about and joined to one of said cylinders.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
2,026,652	Ponte	Jan. 7, 1936
2,082,820	Bouvier et al.	June 8, 1937
2,210,666	Herzog	Aug. 6, 1940
2,284,434	Lindenblad	May 26, 1942