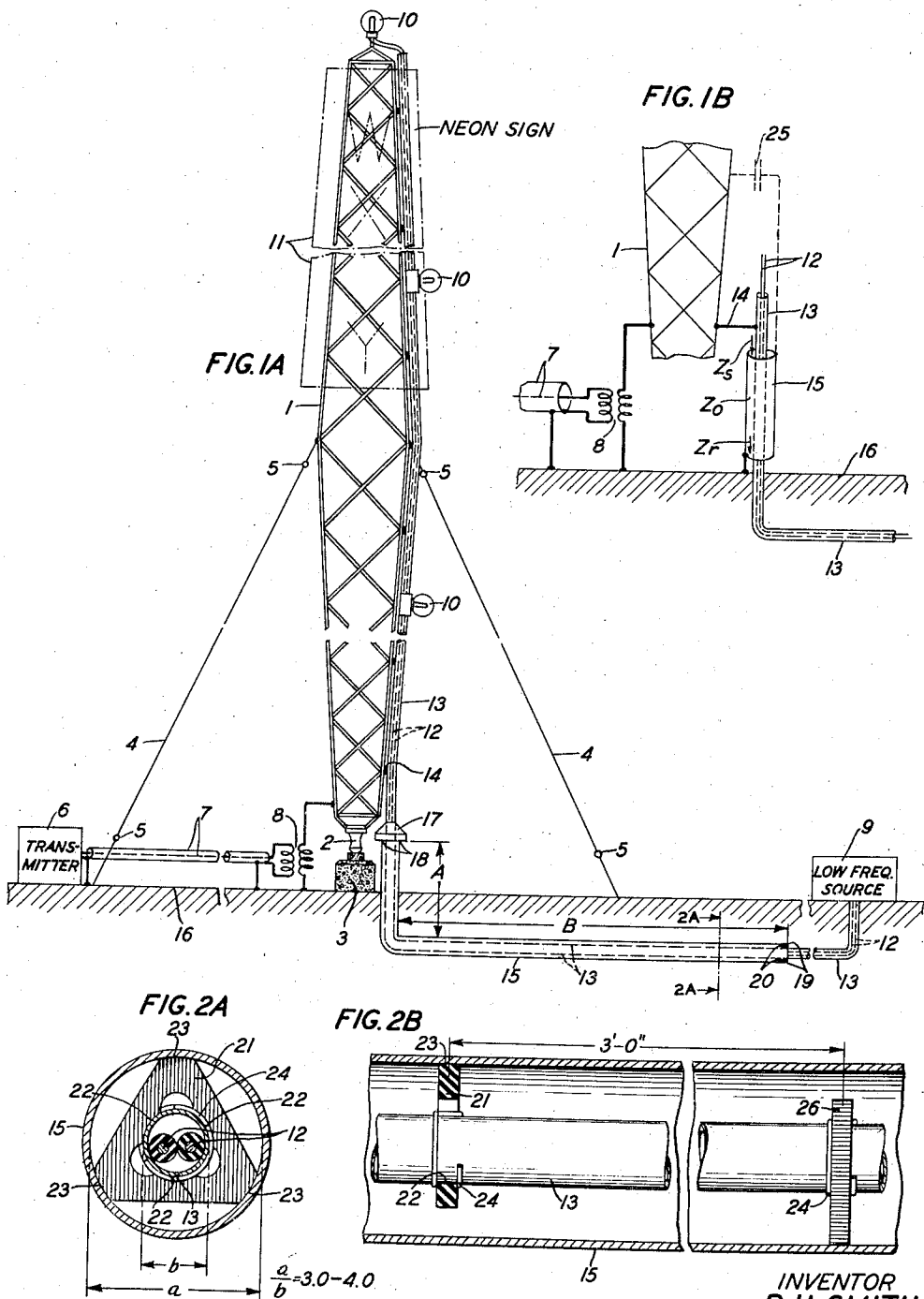


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ANTENNA ACCESSORY

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ANTENNA ACCESSORY

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This invention relates to high frequency systems, and particularly to radio antenna systems and auxiliary apparatus therefor.

As is well known in the radio broadcast art, antennas of the tower, mast or cantilever type are rapidly displacing the familiar wire T type antenna which is ordinarily supported through insulators by metallic grounded or non-grounded towers. While the support tower ordinarily employed in the wire antenna system is of such height as to constitute a menace to aerial navigation, it generally requires only one aircraft warning light, whereas the radiating tower antenna ordinarily requires several warning lights in view of its exceedingly great height. In the case of wire antennas and associated non-radiating supporting towers, various systems or circuit arrangements for attaching commercial power apparatus, such as lights and neon signs, to the towers without affecting the operation of the antenna, have been devised and at present are being satisfactorily used. In the case of the radiating tower antennas insulated from ground, however, the arrangement heretofore utilized for associating the direct or low frequency systems, which are ordinarily grounded at one or more points, to the tower antennas in a manner such as not to impair the efficiency of the antenna, have not in general proven entirely satisfactory.

It is an object of this invention to associate low frequency or direct current auxiliary equipment with radio antennas without impairing the efficiency of the antenna.

It is another object of this invention to attach or connect conductively grounded electrical apparatus to a high frequency system without connecting the system to ground for a given high frequency current.

It is still another object of this invention to associate grounded conductors conveying direct or low frequency current of large amplitude to tower type antennas in a safe and economical manner, and without permitting the flow in said conductor of radio energy of a given frequency.

According to one preferred embodiment of the invention a metallic tubular shield is coaxially associated with the grounded conduit which contains the low frequency power line conductors associated with the warning lamps and neon sign and which is conductively attached to the tower antenna. The shield has a length equal to a quarter of the antenna operating wavelength and at the extremity remote from the antenna is connected through a path of substantially zero impedance to the inner conductor or conduit and to the ground, the shield extremity nearer the tower being electrically associated with the conduit only through the inherent distributed line capacity. The ratio of the inside diameter of the shield to the outside diameter of the conductor

is preferably in the order of 2 to 4. The shield and enclosed conduit portions constitute a very efficient high impedance for the radio frequency energy of the antenna operating frequency supplied to the tower antenna over a separate line and also constitutes a low impedance for second harmonic currents, whereby the tower antenna may be conductively connected to a grounded commercial power system which supplies relatively large low frequency currents to antenna apparatus, without impairing the efficiency of the antenna.

The invention will be more fully understood from the following description taken in connection with the drawing on which like reference characters designate elements of similar function and on which:

Fig. 1A illustrates one embodiment of the invention and Fig. 1B is a schematic circuit useful in explaining the operation of the system of Fig. 1A; and

Figs. 2A and 2B are sectional views of the coaxial line included in the system of Fig. 1A.

Referring to Fig. 1A, reference numeral 1 designates a tower or mast type antenna extending vertically for a distance approximately six-tenths of the antenna operating wave-length above the ground. The antenna 1 is supported on the insulator 2 and concrete base 3 and maintained in position by guy wires 4 which are insulated from the antenna and ground by means of insulators 5. Reference numeral 6 designates a broadcast transmitter which supplies radio frequency energy to antenna 1 over coaxial line 7 and transformer 8. Reference numeral 9 designates a direct current or low frequency commercial power source which is connected to the aircraft warning lights 10 and neon sign 11 by conductors 12. A conduit 13 encloses conductors 12, the conduit being conductively and rigidly attached by means of fixtures 14 to antenna 1. Reference numeral 15 designates a metallic shield enclosing conduit 13 for a distance equal to one-quarter of the operating wave-length the sum of dimensions A and B being equal to one-quarter wave-length. The quarter wave-length coaxial line so formed is buried below the surface of the ground 16 throughout its length, except for a negligible portion having a length of three or four feet and extending vertically above the ground. For a wave-length of 300 meters which is included in the 200 to 550 meter broadcast band the sum of A and B equals approximately 266 feet. Reference numeral 17 designates an insulator type weather hood which serves to prevent rain and snow from entering the interior of the shielded line. The shield extremity 18 nearer the tower is electrically associated with the inner conductor or conduit 13 only through the inherent dis-

tributed capacitance and the remote extremity 19 of the shield is connected to the inner conductor through a short-circuit or path 20 of zero impedance substantially.

Referring to Figs. 2A and 2B, reference numeral 21 designates a triangular or polyhedric insulator which functions to maintain the conduit 13 and shield 15 coaxially aligned. Each insulator contacts the inner conductor at three spaced or separated surfaces 22 and also contacts the inside of the shield at three spaced surfaces 23. The insulators are held in place by means of clips 24. The ratio of the inside diameter a of the shield to the outer diameter b of the inner conductor is preferably of the order of 2.0 to 4.0.

Referring to Figs. 1A and 1B, the operation of the system will now be explained. Radio frequency energy is supplied by transmitter 6 over transmission line 7 and transformer 8 to the tower antenna 1 and low frequency energy is supplied by low frequency source 9 over conductors 12 to the warning lights 10 and neon sign 11. The radio frequency potential established in the antenna is impressed through the antenna distributed capacity 25 and fixtures or connections 14 across the two input terminals of the quarter wave-length line comprising shield 15 and a portion of conduit 13, the input terminals of the line including the extremity 18 of the shield 15. For a more detailed explanation of this theory reference is made to Patent 1,924,115, E. B. Ferrell, August 29, 1933, Fig. 3 and associated description.

Considering the potential supplied by transmitter 6 to the secondary winding of transformer 8, it will be observed, referring to Fig. 1A, that the potential across the secondary winding is impressed on the input terminals (18 and adjacent point of conductor 13) of the coaxial line 15, 13 inasmuch as one terminal of the secondary winding is connected through the lower portion of the metallic tower 1 and the lowest fixture 14 to the inner tubular conductor 13 at a point not enclosed by the outer tubular conductor 15 and the other terminal of the secondary winding is connected through the ground 16 to the conductor 15 at a point near extremity 18. Consequently oppositely polarized or oppositely phased voltages are impressed across the upper or input terminals of the line 13, 15, the far end or remaining terminals of which are connected through substantially zero impedance.

Referring now to Patent 1,963,723, E. J. Sterba, June 19, 1934, the send end impedance may be determined from the equations appearing therein and given below inasmuch as line 13, 15 is a smooth line, that is, a line of uniform surge or characteristic impedance.

$$Z_1 = Z_0 \frac{Z_r \cosh PI + Z_0 \sinh PI}{Z_0 \cosh PI + Z_r \sinh PI} \quad (1)$$

where

Z_1 = sending impedance

Z_0 = surge impedance of the line

Z_r = terminating impedance

P = propagation constant per unit length of line

l = length of the line.

But, as stated in Patent 2,041,378, P. H. Smith, May 19, 1936, page 2.

$$P = \alpha + j\beta$$

Assuming a lossless line, the attenuation constant α which depends upon the physical construction of the line may be neglected, whereby

the propagation constant P is a pure imaginary, that is,

$$P = j\beta$$

But

$$\beta = \frac{\omega}{V} = \frac{2\pi f}{V} = \frac{2\pi}{\lambda} \quad \text{a constant, independent of the line construction}$$

where

ω = angular velocity

β = frequency

λ = wave-length

V = velocity of propagation which, as pointed out in the textbook "Electric Oscillations and Electric Waves" by G. W. Pierce, top of page 334, is the same for open and coaxial lines.

Also, for lossless lines a quarter wave-length long or an odd multiple thereof, the following equation may be derived from Equation (1) in the manner indicated in Patent 1,963,723 mentioned above:

$$Z_0^2 = Z_1 Z_r \quad (2)$$

If Z_r approaches zero, Z_1 approaches infinity. Z_1 would be infinite if the propagation constant P were purely imaginary, that is, if the attenuation constant α were zero. In practice, α does have an extremely small or negligible value.

It has thus been demonstrated that Equation (2) applies to all lossless lines having a uniform surge or characteristic impedance regardless of the type of line construed. For example, it applies to lines comprising open parallel wires, or coaxial lines comprising two spaced parallel conductors or diverging conductors of non-uniform diameter such as disclosed in Patent 1,959,407, E. Bruce, May 22, 1934. Consequently, the short-circuited quarter wave-length line 15, 13 constitutes a high impedance for radio frequency energy of the antenna operating frequency. The quarter wave-length line is a half wave-length long at the second harmonic of the antenna operating frequency and provides a path of small impedance for this harmonic frequency. It will thus be seen that in the system of Figs. 1A and 1B, no radio frequency energy leaks to ground from the antenna although the antenna is conductively connected by means of connections 14 and conduit 13 to the ground.

The arrangement described above is efficient, economical and readily adapted to existing antenna tower systems. In systems in which the power line conductors convey currents of high amplitude, the coaxial type of quarter wave-length line impedance is especially useful and advantageous, as compared to open-wire short-circuited quarter wave-length lines. The coaxial line is safe from an electrical standpoint in view of the relatively small spacing between the power line conductors and between the shield and conduit. In the open-wire type of high impedance, the spacing between the conductors which convey both the radio frequency and low frequency energies, is necessarily large and the spaced and unprotected conductors constitute a menace to the operating personnel.

Although the invention has been described in connection with a particular embodiment, it is to be understood that it is not to be limited to such an embodiment and that other arrangements may be successfully employed without exceeding the scope of the invention.

What is claimed is:

1. In combination, an antenna, a conductor connecting said antenna directly to the earth,

and means for preventing the flow of energy of the antenna operating frequency through said conductor to the earth, said means comprising a tubular conductor enclosing a portion of said first-mentioned conductor and having a length equal to a quarter wave-length or an odd multiple thereof at said frequency, the extremity of said tubular conductor electrically remote from said antenna being directly connected to said first-mentioned conductor.

2. In combination, a first conductor energized with energy of a given frequency, a second conductor associated with one point thereof, and means for preventing the flow of energy of said frequency through said second conductor comprising a tubular conductor having a length equal to an odd multiple including the integer 1 of a quarter wave-length at said frequency and enclosing said second conductor, the extremity of said tubular conductor electrically remote from said point being connected to said second conductor through a path of zero impedance, substantially.

3. In combination, an antenna energized with radio frequency energy, a first conductor positioned adjacent thereto and energized with low frequency or direct current of relatively large magnitude, and means for preventing the flow of said radio frequency energy through the first conductor comprising a pair of coaxial tubular conductors, the inner conductor of said pair enclosing the first conductor and being inductively related thereto and the outer conductor having a length equal to an odd multiple, including the integer 1, of a quarter of the radio frequency wave-length, the extremity of the outer conductor electrically remote from the antenna being connected to the inner conductor through a path of zero impedance, substantially.

4. In combination, a first conductor energized with radio energy of a given frequency, a second conductor connected directly to one point of the first conductor, and means for preventing the flow of said energy through the second conductor comprising a tubular linear conductor coaxially disposed with respect to said second conductor and having a length equal to an odd multiple, including the integer 1, of a quarter of the radio frequency wave-length, the extremity of said tubular conductor electrically remote from said first-mentioned point being connected to the second conductor through a path of zero impedance, substantially.

5. In combination, an antenna supported by structure insulated from the earth, a source of radio frequency energy conductively included between said antenna and the earth, a conduit en-

closing at least one commercial power line, said conduit being conductively connected at one point thereof to said antenna and at another point thereof to the earth, and a high radio frequency impedance included between said points, said impedance comprising the conduit portion included between said points and a tubular conductor positioned coaxially with and enclosing said conduit portion, said tubular conductor having a length equal to a multiple including the integer 1 of a quarter wave-length at said frequency and having its extremity electrically remote from said antenna directly connected to said conductor.

6. In combination, a vertical mast or tower antenna mounted on a base or footing insulator, radio frequency means for energizing said antenna, a grounded conduit conductively attached to said antenna and containing conductors connected between a source of commercial current and apparatus mounted on said antenna, a shield enclosing a portion of said conduit and having a length substantially equal to a quarter wave-length, or an odd multiple thereof, of the operating frequency of said tower antenna, one extremity of said shield being conductively separated from said conduit and positioned above ground, and the other extremity being conductively connected to said conduit, the ratio of the inner diameter of said shield to the outer diameter of said conduit being of the order of 3.5 to 4.0, and polyhedric insulators for maintaining a coaxial relation between said conduit and shield, each insulator contacting said conduit at a plurality of separated areas and similarly contacting said shield.

7. In combination, an antenna energized with radio frequency energy, a first tubular conductor connected to one point thereof through a path of zero impedance for radio frequency energy and enclosing a pair of low frequency power conductors, and means for preventing the flow of radio frequency energy through said conductors comprising a second tubular conductor coaxially disposed with respect to the first tubular conductor and having a length equal to a quarter wave-length or an odd multiple thereof, one extremity of the second tubular conductor being positioned adjacent to a different point of the antenna whereby a radio frequency voltage is established between said extremity and the portions of the other conductors adjacent thereto, the other extremity of the outer tubular conductor being connected through a path of zero impedance for radio frequency energy, substantially, to the first tubular conductor and to the earth.

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