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2,234,293

ANTENNA SYSTEM

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Fig. 1

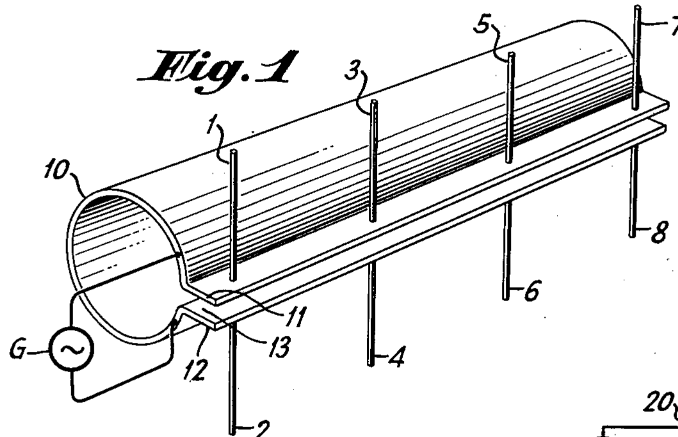


Fig. 2

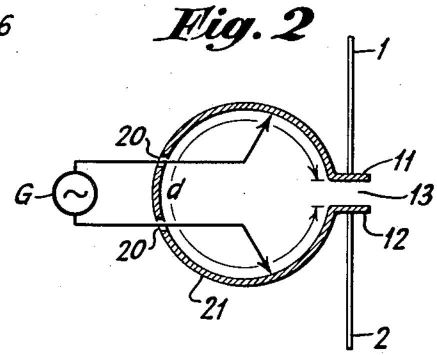


Fig. 3

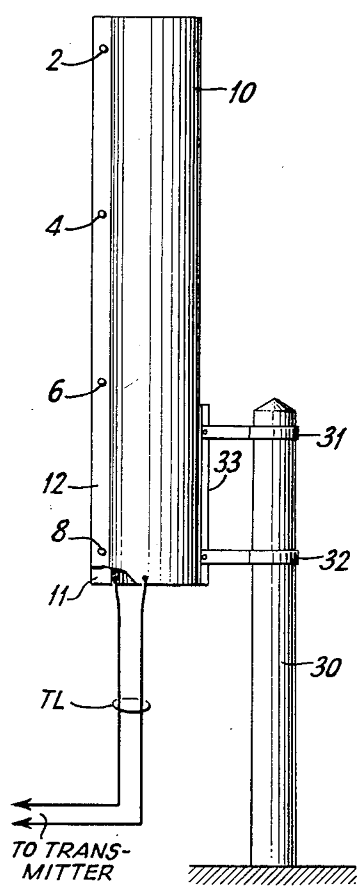
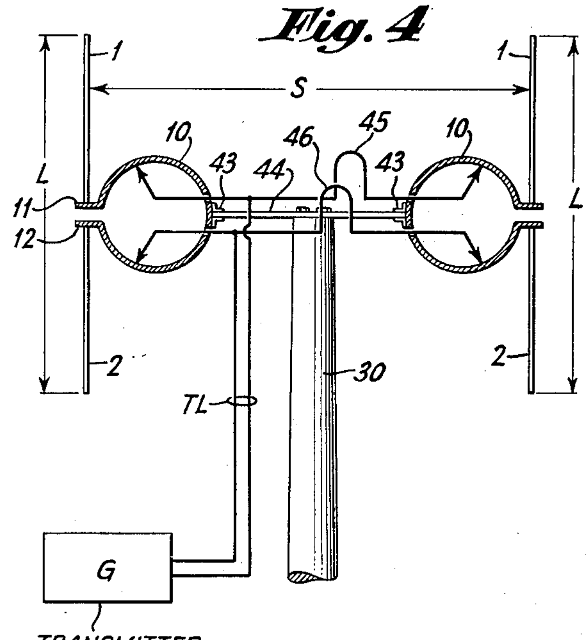


Fig. 4



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2,234,293

ANTENNA SYSTEM

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19 Claims. (Cl. 250—11)

The present invention relates to short wave antennas and, more particularly, to directive short wave antenna arrays.

An object of the present invention is the provision of a short wave antenna array which will be mechanically simple and structurally rugged.

Another object is the provision of a novel means for energizing a short wave antenna array.

Still another object is the provision of simple rugged supporting structure for short wave antenna array.

A further object is the provision of a novel means for coupling a source of high frequency oscillations to utilization apparatus.

Still a further object is the provision of an antenna and reflector array which is entirely grounded against lightning strokes, as well as being mechanically sturdy.

The foregoing objects, and other objects which may appear from the following detailed description, are obtained by mounting dipole radiators along the edges of a longitudinal slit in a split tubular conductor. The split tubular conductor is so dimensioned as to form a tuned circuit resonant at the operating frequency of the antenna system. The slit along the length of the tube and the radiators constitutes the capacity and the inner circumferential length of the wall of the tube and the radiators constitutes the inductance of the tuned circuit. A similar form of construction is utilized for the reflector array, if one is desired.

A more complete understanding of the present invention will be had by reference to the following detailed description which is accompanied by a drawing in which Figure 1 shows in perspective one form of the present invention, while Figure 2 is a cross-sectional view thereof; Figure 3 illustrates a modification of the invention while Figure 4 illustrates the manner of supporting and energizing a reflector array for an antenna such as shown in either Figures 1, 2 or 3.

Referring, now, to Figure 1, I have shown a tubular conductor 10 having flanges 11 and 12 along the edge of the longitudinal slit 13 in the tube. On these flanges 11 and 12 are mounted dipole radiating members 1, 2, 3, 4, 5, 6, 7 and 8. The radiating members are arranged in pairs set at any desirable spacing and may be of any desired length as determined by the operating frequency. The flanges 11 and 12 may be integral portions of tube 10, bent to the desired position, or they may be comprised of separate metal pieces brazed or welded along the edges of the slit to give a desired shape. The shape is shown clearly in the cross-sectional view of Figure 2.

The antenna of my invention may be energized by a transmission line from a source G connected as shown in Figure 1 to one end of the tubular conductor, or the transmission line may be brought in through apertures at the back of the tube at a more nearly central location as indicated in Figure 2. The points of connection of the conductors of the transmission line to member 10 should preferably be symmetrically disposed with respect to slit 13. The feed impedance of the antenna may be adjusted to the impedance of the transmission line or generator by varying the spacing between the points of connection. In operation, the split tubular conductor 10 forms a tuned circuit. The slit 13 or space between the flanges 11 and 12, together with the radiators, constitutes a capacity and the interior circumferential length of the wall of the tube, together with the radiators, constitutes the inductance. This distance is indicated by reference letter d in Figure 2. The length d and the capacity of slit 13 are so proportioned that electrical resonance occurs at the operating frequency of an antenna. The greatest oscillating current occurs at the back wall of the tube at 21 in Figure 2 and the highest oscillating potential exists between flanges 11 and 12 and the radiators attached thereto. The high frequency oscillating potential between flanges 11 and 12 produces high frequency oscillating currents in the individual radiators 1 to 8 so that they radiate in an in-phase relationship as usually provided in broadside antenna arrays. The tube 10 may be mounted horizontally so as to hold the radiators in a vertical position, as shown in Figures 1 and 2, or it may be mounted for vertically polarized radiation to hold the radiators in a horizontal position, as shown in Figure 3, if horizontally polarized waves are desired.

If it is desired to mount the radiators in a horizontal position with the tubular member 10 vertical the split conductor may be made to serve as a mast and transmission line, as well as part of the antenna. The lower end of the split tubular conductor may be fastened to a post 30 (Figure 3) by means of straps 31 and 32 bolted to the back of the tubular conductor. If desired, a flange 33 may be brazed or welded to the tubular conductor for convenience in attaching the straps. If the post 30 is not conducting it is desirable to ground the tubular conductor 10 as a protection against lightning by means of a grounded wire connected to straps 31, 31 or flange 33.

In Figure 3 a portion of the nearer side of the tubular conductor has been broken away at the lower end to show one way of connecting the transmission line TL to the end of the tubular member. If it is desired to energize the tubular conductor from a midpoint the transmission line may be connected as shown in Figure 2.

In each of the embodiments described above the spacing of the radiators along the flanges 11 and 12 may be varied so as to give the optimum results. In some circumstances, better results may be obtained by setting the end radiators 1, 2, 7 and 8 back a short distance from the ends of the split tube. The directivity of the antenna may be controlled by changing the phase of the currents in the end radiators with respect to the currents in the central radiators. A convenient manner of varying the phase relationship is by varying the capacity of the gap 13 between flanges 11 and 12. A narrowing of the gap 13 or widening of the flanges 11 and 12 increases the capacity at that point above the average and, therefore, causes the current to lag in phase at that point; whereas, a decrease in capacity at some other point below the average causes the current to load in phase. The tendency is for all points along the split tubular conductor 10 to have the same phase relations if the structure is entirely symmetrical. However, the end effect of the split tube 10 undoubtedly changes the phase relationship near the ends. For this reason, the radiating members 1, 2, 7 and 8 should not be mounted too near the ends of the tube; if they are mounted comparatively close to the ends then the gap 13 will have to be varied to compensate for this end effect.

The modification of my invention shown in Figure 4 comprises two antenna arrays mounted on a pole to form a directive system with only one direction of maximum response. Each of the antenna arrays is substantially alike and substantially as described with reference to Figure 1. The split tubes 10, 10 are mounted parallel to each other and all the radiators on the flanges 11 and 12 are also mounted parallel to each other. Either of the sets of radiators may be considered the reflector and the other as the antenna, depending upon the exact phase and manner of energization. The antennas are energized in parallel except that in the figure the lines to the right hand antenna are provided with phasing loops 45 and 46 for adjusting the phase of the current in this array for the desired direction and directivity of the beam. The distance S between the radiators of the array, as well as the length L of the radiators, has an important effect on the horizontal and vertical directivity and must be considered in adjusting the dimensions of loops 45 and 46. A convenient manner of mounting the directive system on the top of pole 30 is to fasten the tubes 10, 10 to a flat metallic plate 44 by means of flanges 43. If desired, of course, the radiator system of Figure 4 may be mounted vertically as described with reference to Figure 3.

While I have particularly shown and described several modifications of my invention, it is to be clearly understood that my invention is not limited thereto but that modifications within the scope of the invention may be made.

I claim:

1. Means for coupling a dipole antenna array to a transmission line comprising an electrically conducting tubular member extending the length of said array and forming a substantially closed channel for the transmission of electromagnetic flux from one end to the other, the transverse dimensions of said member being so proportioned that resonance occurs at the operating frequency of said antenna array, said dipoles being coupled to said member at points of maximum oscillating potential.

2. Means for coupling a dipole antenna array to a transmission line comprising an electrically conducting tubular member extending the length of said array and having a longitudinal slit along the length thereof, the capacity between the edges of said slit being so related to the inductance of the circumferential conducting path of said member that said path is resonant at the operating frequency of said array and means for coupling the antennae of said array to the edges of said slit.

3. Means for coupling a dipole antenna array to a transmission line comprising an electrically conducting tubular member extending the length of said array and having a longitudinal slit along the length thereof, conducting flanges along the edges of said slit, the capacity between said flanges being so related to the inductance of the interior circumferential conducting path of said member that said path is resonant at the operating frequency of said array and means for coupling the antennae of said array to said flanges.

4. A directional antenna array comprising a horizontal longitudinal conducting tubular member extending the length of said array, said member having a longitudinal slit along the length thereof, the capacity between the edges of said slit being so related to the inductance of the interior circumferential conducting path of said member that resonance occurs at the operating frequency of said array, vertical radiating members connected to the edges of said slit and a transmission line connected to said tubular member.

5. A directional antenna array comprising a horizontal longitudinal conducting tubular member extending the length of said array, said member having a longitudinal slit along the length thereof, the capacity between the edges of said slit being so related to the inductance of the interior circumferential conducting path of said member that resonance occurs at the operating frequency of said array, vertical radiating members connected to the edges of said slit and a transmission line connected to said tubular member at symmetrical points with respect to said slit.

6. A directional antenna array comprising a vertical electrical conducting tubular member, said member having a longitudinal slit along the length thereof, the capacity between the edges of said slit being so related to the inductance of the interior circumferential conducting path of said member that resonance occurs at the operating frequency of said array, horizontal radiating members connected to the edges of said slit and a transmission line connected to said tubular member.

7. A directional antenna array comprising an electrically conducting tubular member, said member having a longitudinal slit along the length thereof, the capacity between the edges of said slit being so related to the inductance of the interior circumferential conducting path of said member that resonance occurs at the operating frequency of said array, radiating mem-

bers connected to the edges of said slit and a transmission line connected to said tubular member.

8. A directional antenna array comprising a vertical electrically conducting tubular member, said member having a longitudinal slit along the length thereof, the capacity between the edges of said slit being so related to the inductance of the circumferential conducting path of said member that resonance occurs at the operating frequency of said array, horizontal radiating members connected to the edges of said slit and a transmission line connected to said tubular member at symmetrical points with respect to said slit.

9. A directional antenna array comprising a horizontal electrically conducting tubular member extending the length of said array, said member having a longitudinal slit along the length thereof, parallel conducting flanges along the edges of said slit, the capacity between said flanges being so related to the inductance of the circumferential conducting path and said member that resonance occurs at the operating frequency of said array, vertical radiating members connected to said flanges and arranged in a plane perpendicular to said flanges and a transmission line connected to said tubular member.

10. A directional antenna array comprising an electrically conducting tubular member extending the length of said array, said member having a longitudinal slit along the length thereof, parallel conducting flanges along the edges of said slit, the capacity between said flanges being so related to the inductance of the circumferential conducting path and said member that resonance occurs at the operating frequency of said array, radiating members connected to said flanges and arranged in a plane perpendicular to said flanges and a transmission line connected to said tubular member.

11. A directional antenna array comprising a horizontal electrically conducting tubular member extending the length of said array, said member having a longitudinal slit along the length thereof, parallel conducting flanges along the edges of said slit, the capacity between said flanges being so related to the inductance of the interior circumferential conducting path and said member that resonance occurs at the operating frequency of said array, vertical radiating members connected to said flanges and a transmission line connected to said tubular member at symmetrical points with respect to said slit.

12. A directional antenna array comprising a vertical electrically conducting tubular member, said member having a longitudinal slit along the length thereof, parallel conducting flanges along the edges of said slit, the capacity between said flanges being so related to the inductance of the circumferential conducting path of said member that resonance occurs at the operating frequency of said array, horizontal radiating members connected to said flanges and a transmission line connected to said tubular member.

13. A directional antenna array comprising a vertical electrically conducting tubular member, said member having a longitudinal slit along the length thereof, parallel conducting flanges along the edges of said slit, the capacity between said flanges being so related to the inductance of the circumferential conducting path of said member that resonance occurs at the operating frequency of said array, radiating members connected to said flanges and perpendicular thereto and a transmission line connected to said tubular member at symmetrical points with respect to said slit.

14. A directional antenna array comprising an electrically conducting tubular member, said member having a longitudinal slit along the length thereof, parallel conducting flanges along the edges of said slit, the capacity between said flanges being so related to the inductance of the circumferential conducting path of said member that resonance occurs at the operating frequency of said array, radiating members connected to said flanges and perpendicular thereto and a transmission line connected to said tubular member at symmetrical points with respect to said slit.

15. A directional antenna array comprising a plurality of horizontal electrically conducting tubular members extending the length of said array in a parallel relationship, said members each having a longitudinal slit along the length thereof, the capacity between the edges of said slits being so related to the inductance of the circumferential conducting path of each of said members that resonance occurs at the operating frequency of said array, vertical radiating members connected to the edges of the slits along each of said members, a transmission line connected to each of said tubular members at symmetrical points with respect to the slits in said members and means for adjusting the relative phase of energy supplied to said tubular members.

16. A directional antenna array comprising a plurality of horizontal longitudinal conducting tubular members extending the length of said array in a parallel relationship, said members each having a longitudinal slit along the length thereof, parallel conducting flanges along the edges of each of said slits, the capacity between each pair of said flanges being so related to the inductance of the circumferential conducting path of each of said members that resonance occurs at the operating frequency of said array, vertical radiating members connected to each of said flanges and in a plane perpendicular to said flanges, a transmission line connected to each of said tubular members at symmetrical points with respect to said slits and means for adjusting the relative phase of energy supplied to said tubular members by said transmission line.

17. A directional antenna array comprising a plurality of longitudinal conducting tubular members extending the length of said array in a parallel relationship, said members each having a longitudinal slit along the length thereof, parallel conducting flanges along the edges of each of said slits, the capacity between each pair of said flanges being so related to the inductance of the circumferential conducting path of each of said members that resonance occurs at the operating frequency of said array, radiating members connected to each of said flanges, and in a plane perpendicular to said flanges, a transmission line connected to each of said tubular members at symmetrical points with respect to said slits and means for adjusting the relative phase of energy supplied to said tubular members by said transmission line.

18. Means for coupling an antenna to a transmission line comprising an electrically conducting tubular member having a longitudinal slit along the length thereof, the capacity between the edges of said slit being so related to the inductance of the interior circumferential conducting path of said member that said path is resonant at the operating frequency of said antenna,

said antenna being connected to the edges of said slit.

19. Radiant energy apparatus comprising an electrically conducting tubular member having a longitudinal slit along the length thereof, the capacity between the edges of said slit being so related to the inductance of the interior circumferential conducting path of said member that said path is resonant at a predetermined frequency, means for exciting said path at said frequency and utilization apparatus coupled to the edges of said slit.

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