Dec. 17, 1968 A. C. VELDHUIS 3,417,401

LOW INPUT IMPEDANCE DIOPOLE ANTENNA ARRAY

Filed Dec. 7, 1965

FIG. 1

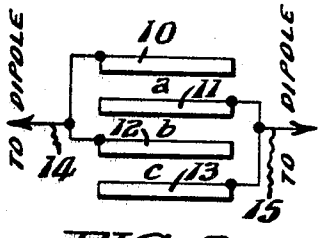


FIG. 2

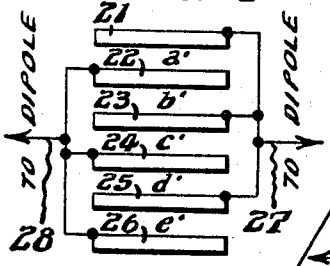


FIG. 3

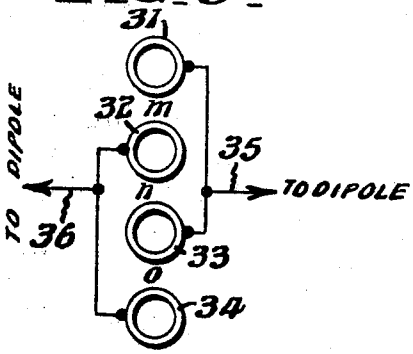


FIG. 4

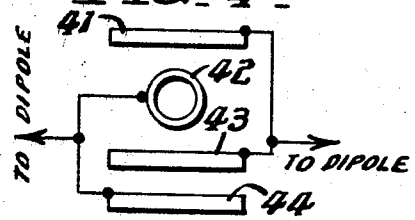


FIG. 5

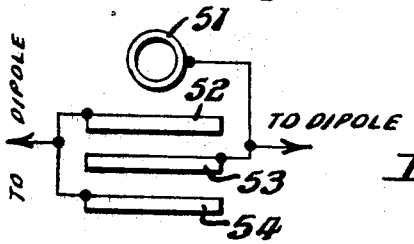


FIG. 6

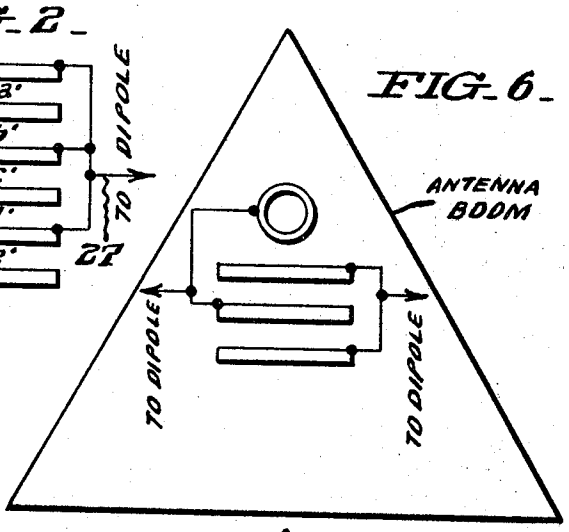


FIG. 7

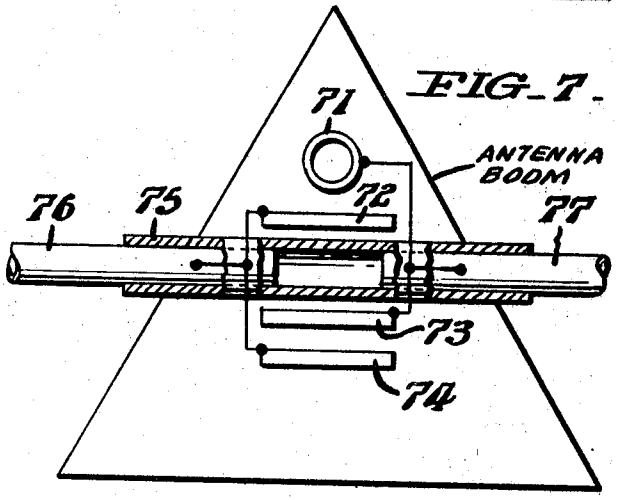


FIG. 8

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LOW INPUT IMPEDANCE DIPOLE ANTENNA ARRAY

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ABSTRACT OF THE DISCLOSURE

A low input impedance antenna is disclosed having dipole elements and at least four transmission line conductors disposed in stacked relationship. Alternate transmission line conductors are connected together at opposite and spaced points along the stack. The dipoles are connected to the connections. Preferably, at least one transmission line conductor is of circular cross section, the remainder being preferably flat strips.

This invention relates to antenna transmission lines, and particularly to transmission lines for antennas required to have low input impedance.

In the design of antennas for low input impedance, such as 50 ohms (one important example being a logarithmically periodic antenna), a difficulty arises in that the balanced transmission line within the antenna is required to have a characteristic impedance which is so low as to be impractical for balanced transmission lines.

The necessity of meeting an antenna input impedance as low as 50 ohms severely limits the design of the balanced transmission line; and transmission lines of such low characteristic impedance necessarily have low power handling capabilities due to their narrow spacing.

The normalized dipole impedance Z_a is often of the order of several hundred ohms, typically 300–400 ohms, unless the dipoles are very fat. For an input impedance R_0 of 50 ohms, the ratio Z_a/R_0 would in such case be 6 to 8. This is the relative characteristic impedance of the dipole element on the basis of the assumed values indicated above. The relative characteristic impedance of the feeder Z_0/R_0 would then, in a typical case, range from 1.25 to 1.19, and Z_0 would range from 52.5 ohms to 59 ohms.

For the balanced transmission line to have a normalized characterized impedance of the order of 53 to 59 ohms would require that the distance between the centers of the transmission line conductors be about 1.1 times the diameter. This is obviously impractical to construct. Furthermore such close spacing severely limits the flashover voltage between conductors, and therefore severely limits the power handling capability. If, instead of round conductors, a strip conductor is used, then, again assuming the values mentioned above, the space between strips will be required to be of the order of 0.16 times the width of the strip. It will be seen that for a reasonable width of strip, the spacing between the strips is required to be so small as to be impractical to construct, and the power handling capabilities are severely limited.

It is of advantage that at least one of the transmission line conductors be of circular cross sections so that it can contain the coaxial feed line and form the infinite Balun that is usually used in low input impedance log periodic dipole antennas. If the other conductor of the transmission lines does not have the same capacity to ground per unit length, unbalances will occur and both the impedance characteristic and the radiation patterns will suffer.

A principal object of the present invention is to provide an improvement in antenna transmission lines which will

substantially overcome the difficulties mentioned hereinabove.

In accordance with my invention, the improvement is achieved by using a plurality of transmission line conductors disposed in interleaved fashion and connected in parallel.

Preferably, at least some of the transmission line conductors are flat strips, but at least one conductor may preferably be of circular cross section so that it may contain the coaxial feed line.

The present invention will be more clearly understood from a consideration of the following description taken together with the accompanying drawings in which:

FIG. 1 is a diagrammatic illustration of a four-strip interleaved parallel-connected transmission line;

FIG. 2 is a diagrammatic illustration of a six-strip interleaved parallel-connected transmission line;

FIG. 3 is a diagrammatic illustration of a four-conductor interleaved parallel-connected transmission line in which all four conductors are of circular cross section;

FIG. 4 is a diagrammatic illustration of a four-conductor interleaved parallel-connected transmission line in which three conductors are strips and one is of circular cross section;

FIG. 5 is a diagrammatic illustration of a four-conductor interleaved parallel-connected transmission line in which three conductors are strips and one conductor is of circular cross section, said one conductor being an outer conductor;

FIG. 6 is a diagrammatic illustration showing the transmission line of FIG. 5 disposed within the triangular boom of the antenna;

FIG. 7 is a diagrammatic illustration of an arrangement generally similar to FIG. 6 but in which the spacing between the center strips is larger, thereby enabling the transmission line to straddle the center insulator of the dipoles;

FIG. 8 is a diagrammatic perspective of a four-strip parallel-connected interleaved transmission line of the type shown in FIG. 1 having transposed connections at successive dipoles.

Referring now to FIG. 1, four transmission-line strips **10**, **11**, **12** and **13** are shown positioned in interleaved manner, with alternate strips **10** and **12** connected in parallel to lead **14** and alternate strips **11** and **13** connected in parallel to lead **15**. The leads **14** and **15** may be assumed to connect to the dipole elements. It will be seen that the four strips **10–13** create three balanced transmission lines, identified in FIG. 1 as *a*, *b*, *c*. The characteristic impedance of each of the three lines *a*, *b*, *c* must be three times as high as the desired characteristic impedance. If, for example, a characteristic impedance of 60 ohms is desired, the spacing between each of the strips **10–13** would be required to be 0.85 times the width of the strips. This is seen to be a considerable improvement over the spacing which would be required between strips if only a single pair of transmission-line strip conductors were used.

In FIG. 2, six interleaved strips **21–26** are shown of which alternate strips **21**, **23** and **25** are connected in parallel to lead **27**, and alternate strips **22**, **24** and **26** are connected in parallel to lead **28**. Leads **27** and **28** go to the dipole elements. The six strips of FIG. 2 form five balanced transmission lines, identified as *a'*, *b'*, *c'*, *d'* and *e'*. If a characteristic impedance of 60 ohms is desired, the separation between strips would be required to be 2.7 times the width of the strips. This is seen to be a considerable improvement over the arrangement shown in FIG. 1.

In FIG. 3, four cylindrical conductors **31**, **32**, **33** and **34** are shown, of which alternate conductors **31** and **33** are

connected in parallel to dipole lead **35**, and conductors **32** and **34** are connected in parallel to dipole lead **36**. These four cylindrical conductors establish three balanced transmission lines, identified as *m, n, o*. If a 60 ohm characteristic impedance is desired, the distance between the centers of the cylindrical conductors would have to be 2.4 times the diameter. If six cylindrical conductors were used in parallel-connected interleaved fashion, in the same manner that the six strips are connected in FIG. 2, five balanced transmission lines would be formed and the ratio between the diameter of, and the required distances between the centers of, the cylindrical conductors would increase to 75.

It is to be noted that each of the transmission lines shown in FIGS. 1, 2 and 3 are completely balanced to ground. This balance to ground is almost completely maintained if one of the inner strip conductors is replaced by a cylindrical conductor with a diameter substantially smaller than the width of the strip. Such an arrangement is indicated in FIG. 4 where conductors **41**, **43**, **44** are strips but the first inner conductor **42** is cylindrical. If the diameter of the cylindrical conductor is not substantially smaller than the width of the strips, a minor unbalance occurs having, however, only second order effects. If the second inner conductor **43** is replaced by a round conductor, the line is again balanced.

In FIG. 5, one of the outer strip conductors is replaced by a cylindrical conductor **51**. This arrangement has advantages and can be constructed in a pure balanced condition when the transmission line is surrounded by a conductor, such as the triangular boom of the antenna and is properly positioned within this triangular conductor. Such an arrangement is illustrated in FIG. 6 of the drawing.

While, in FIGS. 1–6, the spacing between strips is illustrated as being equal, it is not necessary that the spacing be equal. In FIG. 7, the spacing between the center strips **72** and **73** is larger. This has the advantage of allowing the 4-conductor transmission line **71–74** to straddle the center insulator **75** of the dipoles **76**, **77**.

The form of transmission line proposed by the present invention is also advantageous with respect to the connections between the transmission line and the dipole elements. This is illustrated in FIG. 8. At or near the positions of the dipole elements (not shown), interconnecting strap **85** connects transmission-line strips **81** and **83** to the dipole element lead **87**, while strap **86** connects transmission-line strips **82** and **84** to dipole element lead **88**. At the next dipole position, the interconnecting straps are simply reversed in order to reverse the polarity of the dipole connection. That is, strap **89** connects strips **82**, **84** to dipole element lead **91**, while strap **90** connects strips **81**, **83** to dipole element lead **92**.

It will be understood that the arrangement shown in FIG. 8 may be modified, as by replacing one (or more) of the transmission strips with a round hollow conductor to accommodate a coaxial line.

While the preferred embodiments of this invention have been described in some detail, it will be obvious to one skilled in the art that various modifications may be made without departing from the invention as hereinafter claimed.

Having described my invention, I claim:

1. A low input impedance antenna comprising a plurality of dipole elements and at least four transmission line conductors disposed in stacked relationship with alternate transmission line conductors being connected together at opposite and spaced points along the stack, said dipole elements being connected to said transmission line conductor connections.

2. A low input impedance antenna as claimed in claim **1** characterized in that at least some of the conductors of said transmission line are flat strips.

3. A low input impedance antenna as claimed in claim **2** further characterized in that at least a majority of the conductors of said transmission line are flat strips.

4. A low input impedance antenna as claimed in claim **3** further characterized in that all of the transmission line conductors are flat strips.

5. A low input impedance antenna as claimed in claim **3** characterized in that all but one of the conductors of said transmission line are flat strips, said one being a hollow cylindrical conductor.

6. A low input impedance antenna as claimed in claim **5** characterized in that the spacing between the center conductors is larger than the spacing between the outer conductors.

7. A low input impedance antenna as claimed in claim **6** characterized in that the antenna includes a triangular boom and in that the transmission line conductors are disposed within said boom.

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ELI LIEBERMAN, *Primary Examiner.*

U.S. Cl. X.R.

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