April 11, 1950 | E. A. LAPORT | 2,503,952

TRAVELING WAVE ANTENNA

Filed March 19, 1946

Fig. 1

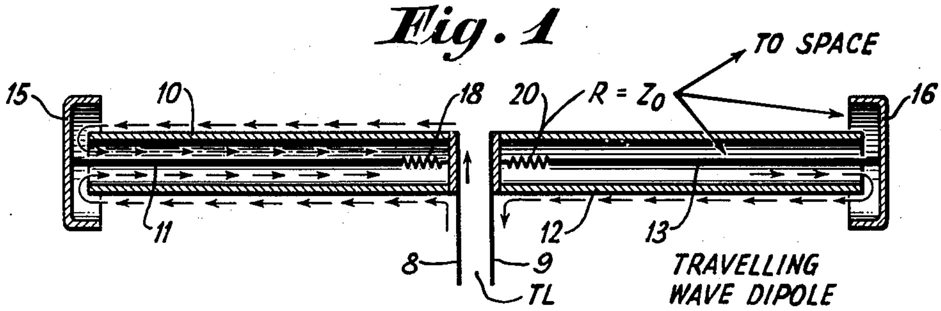
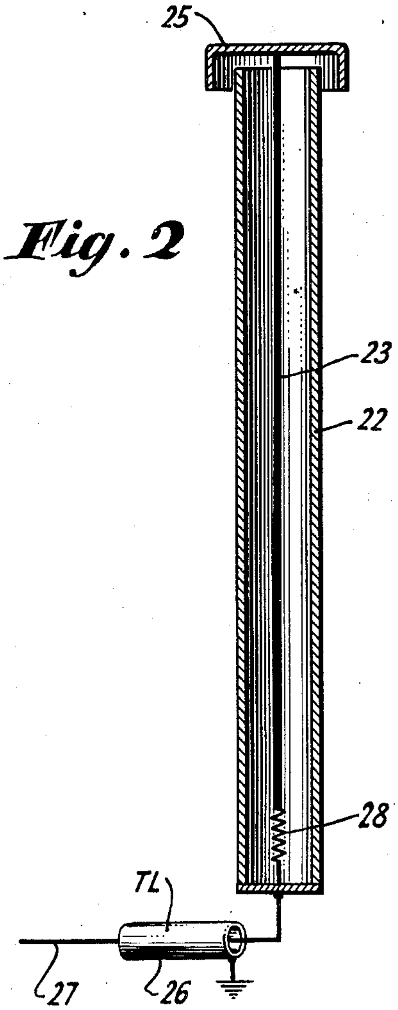


Fig. 2



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TRAVELING WAVE ANTENNA

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The present invention relates to a travelling wave antenna and more particularly to such antennas in which the length of the radiating conductor may be of arbitrary length.

An object of the present invention is to achieve substantially uniform input impedance in an antenna over a wide range of frequencies.

Another object of the present invention is to provide an antenna in which the current distribution thereon is of constant amplitude, but variable phase, along the length of the antenna conductor and in which the input impedance remains constant for any frequency which may be applied to the input terminals of the antenna.

The foregoing objects and others which may appear from the following detailed description are attained by providing an antenna in the form of a concentric transmission line completely closed on the generator end.

The outside of the outer conductor of the concentric line forms the antenna propagating its field in free space. The energy which reaches the remote end of the antenna and is not propagated into space is guided into the inner space of the concentric line where it is dissipated by terminating the inner transmission line in a dissipating resistor, having a resistance equal to the characteristic impedance of the antenna.

The present invention may be fully understood by reference to the following detailed description which is accompanied by a drawing in which:

Figure 1 illustrates a travelling wave dipole antenna constructed according to the principles of the present invention, while

Figure 2 illustrates in cross section a travelling wave vertical antenna embodying the principles of the present invention.

Referring now to Figure 1 there is shown a balanced transmission line TL having conductors 8 and 9. The conductors 8 and 9 are connected to the adjacent ends of hollow tubular conductors 10 and 12. The adjacent ends of the conductors 10 and 12 are closed by conductive plugs. Within conductor 10 and concentrically arranged with respect to the conductor is an inner conductor 11 connected at the free end of conductor 10 to a covering cap 15 which surrounds the open end of conductor 10 but is not in contact therewith. It may be held in position in the spaced relationship with the end of conductor 10 as shown in the drawing, by means of insulators (not shown). The inner end of conductor 11 is connected to the inner side of the plug closing hollow conductor through a resistor 18

Similarly hollow conductor 12 contains there-

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within and in concentric relationship therewith an inner conductor 13 connected at the free end of conductor 12 to a cap 16 similar to cap 15 and terminated at its other end by a resistor 20.

Now, when high frequency energy is applied to conductors 8 and 9 of the transmission line TL, current from the transmission line flows along the outer surface of conductors 10 as indicated by the arrows, propagating its field into free space. Some of the energy flowing along the conductors is not radiated into the surrounding space and arrives at the open end of conductor 10. There it is guided into the inner space of the concentric line, formed by tubular conductor 10 and inner conductor 11, and is carried to the closed end of tubular conductor 10 where it is dissipated across resistor 18. Similarly, but in an opposite instantaneous phase relationship energy flows along the outside of conductor 12, the excess energy not radiated into free space being dissipated in a resistor 20. By absorbing and dissipating the excess energy arriving at the free ends of tubular conductors 10, 12, standing waves are eliminated from the antenna and its impedance becomes a constant resistance equal to its characteristic impedance. Its characteristic impedance is given by the relationship

$$Z_0 \doteq 138 \log \frac{2L}{r}$$

where L is a length of the antenna and r is the radius of the antenna conductor. To achieve impedance matching at the free ends of the antenna, the inner transmission lines 10, 11 and 12, 13 must have a characteristic impedance

$$Z_0 = 138 \log \frac{r}{\rho} = 138 \log \frac{2L}{r_1}$$

where ρ is the radius of the inner conductor where r_1 is the inner radius of the outer conductor

Heretofore known types of dipole antennas, in general, function on the standing wave principle because of the reflection of charges in the system from the free ends of the antenna. Interference produced by charges moving in both directions on the antenna produce the well-known approximately sinusoidal current distribution along the length of the antenna conductors but also cause the input impedance to vary over wide ranges both in reactance and resistance. This produces the effect known as antenna selectivity in wide band types of transmitters and requires special tuning and coupling provisions where the same antenna is to be used on several different frequencies.

By absorbing the energy normally reflected from the free ends of the dipole, the charges on the antenna travel in one direction only. Thus, there is obtained a current distribution of constant amplitude but variable phase along the antenna conductors and the input impedance remains constant no matter what the applied frequency is, just as in the case of an infinite transmission line.

The modification of the present invention shown in Figure 2 includes a hollow vertical conductor **22** having therewithin a coaxially arranged inner conductor **23**. Conductor **23** at the lower end is connected to the inner closed end of tubular conductor **22** through resistor **28**. The cap **25** connected to the upper end of conductor **23** is spaced away from the edges of the upper end of tubular conductor **22** in the same way as described above with reference to caps **15** and **16**. In the modification in Figure 2, the antenna is shown as being fed through a concentric transmission line TL having an inner conductor **27** and a concentrically arranged grounded outer shell conductor **26**.

While I have illustrated a particular embodiment of the present invention, it should be clearly understood that it is not limited thereto since many modifications may be made in the several elements employed and in their arrangement and it is therefore contemplated by the appended claims to cover any such modifications as fall within the spirit and scope of the invention.

What is claimed is:

1. A travelling wave antenna including a hollow conductor of arbitrary length with respect to the frequency of operation, means for applying high frequency energy to said conductor at one end thereof to propagate said energy along the exterior of said conductor to the other end thereof, means for inducing energy arriving at the other end of said conductor to flow down the interior thereof and means within said hollow conductor for dissipating substantially all of the energy flowing within said hollow conductor thereby to provide a substantially reflectionless termination.

2. A travelling wave dipole antenna including a pair of hollow conductors of arbitrary non-resonant length, said conductors being arranged in a coaxial end to end relationship, said conductors having their adjacent ends closed, means for applying high frequency energy to said conductors at their adjacent ends to propagate said energy along the exterior of said conductors to the non-adjacent ends thereof, means for inducing energy arriving at the non-adjacent ends of said conductors to flow down the interior thereof and means there within for dissipating substantially all of the energy flowing within said conductors thereby to provide a substantially reflectionless termination.

3. A travelling wave antenna including a hollow conductor of arbitrary length, said conductor being closed at one end, means for applying

high frequency energy to said conductor at said end to propagate said energy over the exterior of said conductor to the other end thereof and an inner conductor coaxially arranged within said hollow conductor, a resistor connected between said inner conductor and said closed end, means for inducing energy arriving at the other end of said hollow conductor to flow along said inner conductor.

4. A travelling wave antenna including a hollow conductor of arbitrary length, said conductor being closed at one end, means for applying high frequency energy to said conductor at said end to propagate said energy over the exterior of said conductor to the other end thereof, and an inner conductor coaxially arranged within said hollow conductor, a resistor connected between said inner conductor and said closed end, means for inducing energy arriving at the other end of said hollow conductor to flow along said inner conductor, said means including a cap connected to said inner conductor covering and surrounding the other end of said hollow conductor.

5. A travelling wave dipole including a pair of hollow conductors of arbitrary length, said conductors being arranged in a coaxial end to end relationship, said conductors having their adjacent ends closed, means for applying high frequency energy to said conductors at their adjacent ends to propagate said energy over the exterior of said conductors to the other ends thereof, an inner conductor coaxially arranged within each of said hollow conductors, a resistor connected between each of said inner conductors and the adjacent closed ends of said hollow conductors, means for inducing energy arriving at the outer ends of said hollow conductors to flow down the interior thereof, said means including a cap connected to each of said inner conductors covering and surrounding the outer ends of said hollow conductors.

6. A travelling wave antenna including a hollow conductor of arbitrary length, one end of said conductor being closed and adapted to be connected to a source of high frequency energy to propagate the same over the exterior of said conductor to the other end thereof, a cap covering and surrounding said other end of said conductor, and a resistance element within said hollow conductor and connected between said closed end of said conductor and said cap.

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