What would an Antenna Special be without food for thought? W5JJ presents some basic information on traveling-wave antennas for us to think about.

Traveling-Wave Antennas

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Most radio amateurs think of antennas in terms of resonant radiators, of which the Hertz and the Marconi are the better known. Of these, the half-wave Hertz is typical. With it, radio frequency energy is fed (usually) into the mid-point, from which point it flows outward to the two ends. There the incident wave encounters an open circuit, which results in a reflected wave being generated. This reflected wave flows back toward the feed-point. Because of phasor relationship between the voltage components and the current components of the incident and the reflected waves, an interference pattern is established over the length of the half-wave antenna. This interference pattern results in the familiar *E* and *I* curves so often used to depict the standing waves on a half-wave resonant radiator.

There is another type of radiator, the traveling-wave antenna, that does not depend upon resonance for optimum operation. It therefore may be used over a broad spectrum of frequencies, in some instances as great as 10 to 1, with no change in physical dimensions. Not being resonant, it does not have standing waves. Because of this its current distribution is uniform over its length, except for steady diminishing as the far end is approached.[1] Several versions of the traveling-wave antenna are in more or less common use. These are the terminated rhombic, the terminated Vee, long helical beams, the disc-cone, and the long-wire. That term, *long-wire*, is used here in its correct meaning—that of a radiator many wavelengths long at its operating frequency.[2] The long-wire version is the one most easily constructed and the best suited for explanation. It, therefore, will be the subject of this article.

Before discussing electromagnetic waves, let's review wave motion in water. Visualize, if you will, a large circular pond, one holding water in a placid, totally undisturbed state. Now let there be a stone dropped into the water at the pond's center. In your mind's eye, observe the waves formed by this disturbance, considering only those traveling in a straight line through a narrow corridor from the center toward the distant shore. Note that as the waves extend toward the distant shore, their magnitude becomes progressively less and less until the waves become too small to be detected by conventional means and therefore may be disregarded.

Now let's return to the electromagnetic spectrum, to that portion containing the h.f. bands used by radio amateurs. We'll base this study of electromagnetic waves on their behavior when radiated from a designated type of radiator. This radiator will be a long, thin conductor extending out in a straight line at a constant height over uniform earth. This conductor will have a low but finite ohmic resistance and will be many wavelengths long at the frequency to be considered. One end will be fed radio frequency energy from a generator. The other end will be an open circuit. There will be no ground and no terminating resistor.

As alternating current from the generator traverses the conductor, it causes a field to be established about it—several fields, in fact. Let's deal first with the "near field," or Fresnel zone. This zone has two fields, the electromagnetic and the electrostatic, which have a phase (or time) difference of 90°. The induction or electromagnetic field is in phase with the current in the radiator.[3] The induction field is of importance only in the immediate vicinity of the radiator. Its lines of force build up and collapse back into the conductor twice each cycle.[4] We will disregard the near field and go to consideration of the "far field," or Fraunhofer region. In this region the electromagnetic (or H) field and the electrostatic (or E) field are in time coincidence. That is, they are in phase. The two fields, however, are at right-angles to one another and also to the direction of wave propagation.[5] They oscillate in phase, and the ratio of their amplitudes remains constant. The two fields vary in magnitude and reverse in direction in consonance with the current from the generator. It is these two fields that are used in radio communication.

As these fields expand and contract twice each cycle, not all of the energy contained therein is returned. Much of it is "lost" to space. That, of course, is what is desired! This means that each successive wave along the conductor will have a bit less amplitude. (Remember the waves on the pond?) This "loss" of amplitude is quite rapid in relation to wavelengths traveled.[1] Because of this, no terminating resistor is needed.

Just how rapid the "loss" of amplitude is is dependent upon (among other things) the diameter (or cross-section) of the radiator. If the conductor is sufficiently large, so much of the energy will be radiated that the length need be only about two wavelengths to avoid any significant reflections.

Like all long-wire antennas, the traveling-wave antenna has a multiplicity of lobes. The direction of the electric field reverses for each lobe. These lobes tend to slant toward the far end of the radiator. The longer the antenna, the greater the slant. Measured from a reference line at right-angles to the radiator, for five wavelengths the slant is 68°; for ten wavelengths it's 78°. These lobes account for the directivity.

Traveling-wave antennas are effective for both transmission and reception. One version, the Beverage, is perhaps the very best antenna for reception of "long-wave" (MF and LF) signals under conditions of heavy atmospherics.

One might sum up the good and bad points of the traveling-wave antenna in a concise listing.

Advantages

a. Broad frequency response.
b. Directional.
c. Simple to build; no critical dimensions.
d. Highly efficient.

Disadvantages

a. Needs much space for installation.
b. Directivity not easily changed.
c. Radiation resistance difficult to compute.[2]

The traveling-wave antenna has its place in the roster of amateur radio antenna systems. Don't overlook it!

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References

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