Question and Answers
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ANTENNAS (OR IS IT ANTENNAE?) AND TRANSMISSION LINES

Part II

1 (Q) What is the formula for determining the length of a resonate 1/2 wavelength antenna ?

(A) The formula, in feet. is 468/Frequency (in MHz). During the many years that I have taught electronic classes, I've developed this explanation to help students remember this formula: Simply write down the EVEN numerals from 2 through 10. Then following the Olympic Committee's scoring procedure, we will delete the lowest (2) and the highest (10) scores (numbers) leaving our 468. The frequency, we must already have at hand. Of course, a 1/4 wavelength antenna would be half of this computed length. Remembering this procedure should make it easier to recall for tests.

2. (Q) Does the resonate antenna offer the very best radiator for a given frequency?

(A) No, not if a tuner or coupler is to be properly utilized. With a tuner, either a shorter or longer antenna may be successfully used. The key to the success of any antenna system is the radiation resistance of the antenna and its associated ground resistance, not necessarily its natural resonance. I have used two aluminum ladders leaned against each other with a folded sheet of plastic separating them at the top, each ladder extended to about 27 feet and both on plastic feet, making an inverted"V". These were used to work just above the 80 meter band and did a creditable job working emergency services on an actual mission for several days, to stations within 500 miles or even more. One author recently discussed using a lounge chair and having good results.

3. (Q) Continuing the question above; if space is not a consideration, is it better to have an antenna longer or shorter than a resonate antenna for the frequency of interest, assuming we have a tuner?

(A) Big time question. A tuner will make the SYSTEM resonate, if within the tuner's range, regardless. However, it has been my experience that a longer antenna will "capture" more signal for reception (and transmission) than a shorter wire in a given location, therefore, I would recommend a longer radiator over a shorter one. Example: You older operators may remember the household AM radios of the past, those with a "loop" antenna wound usually on a waxed cardboard form on the back of the radio, these loops having a trimmer capacitor to tune the loop. One could tune the trimmer to cause the antenna to resonate at the center of the band, usually at 1000 kHz. After tuning the loop to resonance, one could attach a piece of wire to the loop and the signal would be stronger. More "capture" area, obviously.

The discussion above would be incomplete without adding that antenna RADIATION RESISTANCE and local GROUND RESISTANCE are the basic ingredients for a successful radiator. A tall vertical antenna in one location may not perform as well as a shorter element at a more desirable location, even with a tuner or coupler. Happily, however, we can usually improve a given location with the addition of ground radials and/or loading coils..

4. (Q) What is meant by the term, "Radiation Resistance?"

(A) We show two accepted definitions. (1) Simply stated, radiation resistance is the value of a resistor that would, when connected in such a manner as to replace the antenna, consume the same power as the antenna when the antenna is properly connected. (2) It may also be defined as the power radiated by the antenna divided by the square root of the effective antenna current when referenced to a specific point.

Obviously, the first is the easiest to understand without math. The second definition is derived from working the AC power formula, P = I squared times R. It can be seen that R = P/(I squared).

5. (Q) What is meant by the term "Ground Resistance?"

(A) In generalization, this means the opposition of the soil or earth to the flow of current through it. In our discussion here, this would be the opposition to RF current. Further, the value of ground resistance is determined, at least in part, by nature and the moisture content of the soil in the immediate area. These in turn may be controlled or effected by the earth's material and composition. These then may be altered by the physical dimensions of our connections to earth - driven ground rods, balls of wire deeply buried, added radials, etc., and finally by the electrolytic action within the earth, usually due to chemical differences.

6. (Q) Does a tuner actually tune the antenna?

(A) This is one of the most debated questions going. The answer is a resounding YES. What a tuner does is that it tunes the antenna "SYSTEM." Any antenna, even a resonate antenna, has two components, Resistance and, either an Inductive or a Capacitive component, however minute'. The transmitter would prefer a pure resistance as its output load, normally 50 ohms for the present day transceivers. A non-resonate antenna will have an impedance somewhat removed from the desired 50 ohm/zero impedance reference, while a resonate antenna would be much closer to the pure resistance of 50 ohms. The tuner (or coupler) tunes the antenna system by adding enough inductance or capacitance to the SYSTEM, to satisfy the transceiver. While doing this, the antenna SYSTEM is also tuned to resonance. It should be noted, however, that any SWR caused by a physical mismatch, is still present. Such SWR can only be eliminated by reconstructing the system. The tuner simply tunes out the EFFECT of that mismatch and in so doing, satisfies the transmitter and at the same time, resonates the antenna SYSTEM. To further this answer, it can be shown that, if the tuner is placed at the junction of the transmission line and the antenna and properly tuned, it IS tuning the antenna. It can be further shown, that if the tuner is placed at the operating position and properly tuned, the ANTENNA CURRENT would be the same as if the tuner were placed at the transmission line/antenna junction. What does this mean? Hey, the tuner DOES tune the antenna, regardless to where it is placed. I KNOW; many books will disagree, but they just haven't analyzed the real world deep enough!

7. (Q) Does it help to have a tuner or coupler when our antenna is cut to resonance?

(A) Probably. Nothing in this world is perfect. The tuner will null out the minor imperfections in our antenna system, but may add a slight insertion loss, but usually an improvement is evident..

8. (Q) A recent statement in one of the nationally acclaimed pubs states that an HF antenna should be erected using the largest gauge wire possible for the span, in order to get the widest possible bandwidth. Is this really necessary?

(A) This is a common misconception. There is no measurable advantage in using a larger gauge wire for HF. While it is true that when we use a conductor diameter which is an appreciable percentage of the length of an antenna an improvement in the bandwidth occurs, but any gauge we could use for HF does not approach the diameter-to-length ratio that would give any measurable advantage. A 6 gauge conductor will offer no measurable advantage in broadband coverage, only in an improved antenna radiation resistance and in physical strength and durability.

9. (Q) Which is the better choice, a tuner or a coupler?

(A) Another controversial question. A coupler must be installed at, or extremely close to the juncture of the feed line and the antenna. For a dipole, this would mean suspending the coupler high in the air, at the center point or the insulator; at the feed point. For a vertical antenna, this is not a problem as a more practical location is provided at the base of the antenna. An advantage of using the coupler is that it will tune the antenna directly and any SWR loss, although small, that would normally occur in the tuner feed line-to-antenna may be reduced, at the feed point. The transmitter would then see no SWR on the feed line. The resultant loss due to the resistance of the feed line, caused by the otherwise present SWR, is eliminated. Two disadvantages may be that the coupler must be mounted remote from the operating position and its presence in an elevated antenna may alter the normal E and I lines of the radiating elements, it is heavy and its size offers much more wind resistance. If an automatic coupler is used, power feed and perhaps control lines, must be provided to the remotely mounted unit as well.

The tuner, however, is located at or near the operating position, ready at hand. It will tune the entire antenna system, including the feed line. While the system may be tuned, any physical mismatch present without the tuner, remains present and causes a slight loss due to the loss in the feed line. This will be very minor however, and will usually be so slight that it will offset any advantage offered by the remote mounting of the coupler. Measured field strength will normally show no measured difference between the coupler and tuner, unless in some extreme case, such as that of very long or lossey feed lines. Normally an external tuner or coupler will give better results than the built-in tuner in most present day transceivers.

10. (Q) Does an antenna erected for HF use need to be high in the air.

(A) Not necessarily, dependent upon purpose. The US military and others now utilize a low mounted type of antenna for their reliable communications within a radius of 800 miles. This new system is called the Near Vertical Incidence Sky-wave, or NVIS. The ideal NVIS antenna would be a dipole installed 1/8 wavelength above the surface. You will hear much of this in the future.

To be continued. We will go into transmission line theory next.