Tech Note - Theory - 09 The Antenna as a Resonant Device

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Electricity travels through a conductor at close to the speed of light. When it reaches a discontinuity in the conductor, it is reflected back toward the source. If the current is alternating, and if the reflected current reaches the source or feedpoint at the right instant, it is reinforced by succeeding cycles until relatively little energy is needed to maintain a standing wave on the antenna. The action compares to that of a swinging pendulum which is reinforced by a slight push at exactly the right instant in each cycle of its swing.

Have a look at Fig 1. and follow this action: Current enters the antenna (A) and moves from the feedpoint towards the ends (B). It reaches the end and having nowhere to go to dissipate its energy, is reflected (C) back toward the source (D) where the next cycle arrives at the same instant to reinforce the first cycle (E). This continues ad infinitum so long as energy is fed to the antenna.

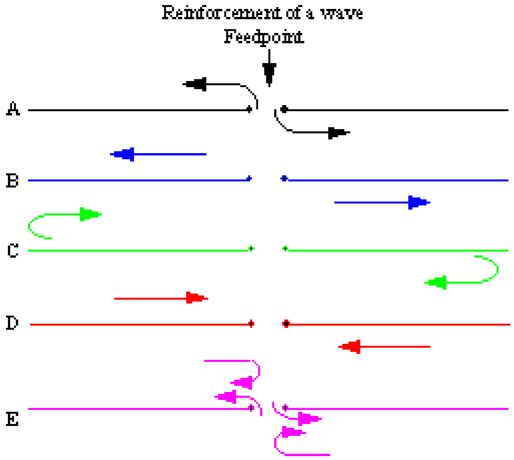

Fig. 1

Refer to Fig. 2a and notice the current and voltage distribution along a half wave antenna. Observe the relative voltage and current levels at any point, the approximate impedance with ohms law being Z=E/I .

As with the swinging pendulum, the amount of push needed to maintain oscillation is least where the volume of current is greatest. Consequently, in a resonant state the push or voltage is low at the centre where the current is greatest and highest at the ends where the push is needed to send the current in the opposite direction.

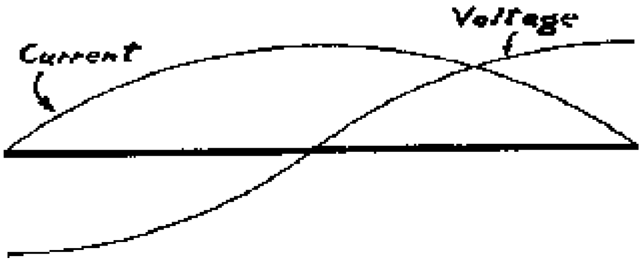

Fig. 2a

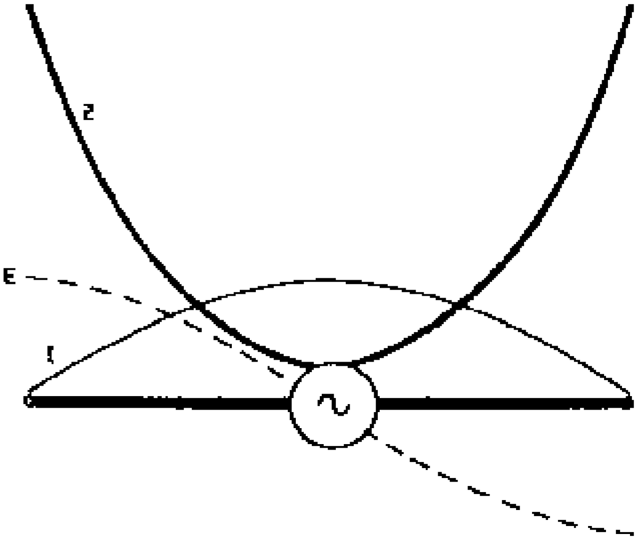

Fig. 2b

Ohms law applies. In the centre of Fig 2b., the current is high and the voltage is low. Therefore resistance is low, at the ends the opposite condition exists and the impedance is high. Theoretically a half wave antenna should look like a short circuit at the exact centre, however the power consumed by the resistance of the conductor and by the radiation resistance presents a load that appears to be a workable value of DC resistance. Also when the antenna is fed at the end, instead of looking like an infinite impedance (open circuit) it again appears to have a real workable amount of resistance.

Any antenna that is an odd number of half wavelengths long has a low impedance in the centre, the exact amount depending on the antenna configuration. An antenna that is an even number of half wavelengths long has a high impedance in the centre. Antennas that are any multiple of half wavelengths long have a high impedance at the ends.

An antenna of a quarter wavelength can be fed with respect to ground under conditions similar to those of a half wave antenna being fed in the centre. In this case ground acts as the other half of the antenna, though an infinitely long half. Only the hot side is resonant.

The half wave dipole is the simplest, most basic of naturally resonant antennas. It consists of two equal length conductors supported end to end for a total of a half wavelength. The antenna is fed by connecting the source between the two halves. Most of the common antenna configurations are based on the half wave dipole. The formula to calculate the length is wl/2=150/f mhz.=length in metres or 150X3.2/f mhz.=468/f mhz.=feet. We do a mod to the formula due to electricity traveling slower in a conductor than in free space. About 4.9 % slower so 492 x 95.1 %=468. A half wave of wire=468/f mhz. In feet

Summary:

1. Radiation will only occur from an open oscillatory circuit. That is one in which the lines of force are allowed to spread over a wide area.
2. An alternating current must be made to circulate in this antenna circuit so that the lines of force will alternately rise and collapse
3. At low frequencies, no radiation will occur because the lines of force have sufficient time to return to the circuit before current reverses.
4. At high frequencies (above 10 Khz.) many of the lines of force will not have time to return to the antenna wire before the current reverses and therefore be forced off into space by the newly created field.
5. As the lines of force leave the antenna the electric and magnetic components are at right angles to each other.
6. In the vicinity of the antenna the wave front is curved but at some distance from the antenna the electromagnetic lines are perpendicular to the earth. The wave is now said to be normally polarized.
7. As the wave expands outward from the antenna the lower part of the wave (earth bound wave) is directed along the surface of the earth and the upper part (skywave) is directed toward the ionosphere.
8. Due to absorption in the earth and intervening objects the earth bound portion is gradually consumed. This drag placed on the lower part of the wave causes the wave front to tilt forward (dig in) and thus for low or medium frequencies the wave follows the curvature of the earth.
9. At the high radio frequencies the absorption in the earth and intervening objects (hydro wires, telephone lines, TV antennas etc.) is so great that the earth bound wave is entirely consumed at a relatively short distance from the antenna. This leaves only the skywave available for long distance communication.
10. The power radiated is approximately proportional to the square of the current measured at the base of the antenna multiplied by the square of the effective height and divided by the square of the wavelength.

Or if we increase the current or the effective height or reduce the wavelength (increase freq.) the power radiated will be increased.