# BEVERAGE ANTENNA BACKGROUND INFORMATION

## Definition

The **Beverage Antenna** is an inexpensive but very effective long wire receiving antenna. It consists of a wire one or two wavelength long.

## Basics

The Beverage Antenna is a relatively inexpensive but very effective long wire receiving antenna used by amateur radio, shortwave listening, and longwave radio DXers and military applications. Harold H. Beverage experimented with receiving antennas similar to the Beverage antenna in 1919 at the Otter Cliffs Naval Radio Station. By 1921, Beverage long wave receiving antennas up to nine miles (14 km) long had been installed at RCA's Riverhead, New York, Belfast, Maine, Belmar, New Jersey, and Chatham, Massachusetts receiver stations. The antenna was patented in 1921 and named for its inventor Harold H. Beverage. Perhaps the largest Beverage antenna—an array of four phased Beverages three miles (5 km) long and two miles (3 km) wide—was built by AT&T in Houlton, Maine for the first transatlantic telephone system opened in 1927.

While these antennas provide excellent directivity, a large amount of space is required. Beverage antennas are highly directional and physically far too large to be practically rotated so installations often use multiple antennas to provide a choice of azimuthal coverage.

A Beverage consists of a wire one or two wavelength long (hundreds of feet at HF to several kilometres for longwave). A resistor connected to a ground rod terminates the end of the antenna pointed to the target area; a 470 ohm non-inductive resistor provides excellent results for most soils. A 50 or 75 ohm coaxial transmission connects the receiver to the opposite end of the antenna through an impedance-matching transformer. Some Beverage antennas use a two-wire design that allows reception in two directions from a single Beverage antenna. Other designs use sloped ends where the center of the antenna is six to eight feet high and both ends of the antenna gradually slope downwards towards the termination resistor and matching transformer.

**Technical Description**

Harold Beverage discovered in 1920 that an otherwise nearly bidirectional long wire antenna becomes uni-directional by placing it close to the lossy earth and by terminating one end of the wire with a non-inductive resistor with a resistance approximately matched to the surge impedance of the antenna. This was the fundamental discovery in his 1921 patent.

The Beverage Antenna relies on "wave tilt" for its directive properties. At low and medium frequencies, a vertically polarized radio frequency electromagnetic wave traveling close to the surface of the earth with finite ground conductivity sustains a loss that produces an electric field component parallel to the Earth's surface. If a wire is placed close to the earth and approximately at a right angle to the wave front, the incident wave generates RF currents traveling along the wire, propagating from the near end of the wire to the far end of the wire. The RF currents traveling along the wire add in phase and amplitude throughout the length of the wire, producing maximum signal strength at the far end of the antenna where a receiver is typically connected. RF signals arriving from the receiver-end of the wire also increase in strength as they travel to end of the antenna terminated in a resistor, where most of the energy propagating in that direction is absorbed.

Radio waves propagate by the ionosphere at medium or high frequencies (MF or HF) typically arrive at the Earth's surface with wave tilts of approximately 5 to 45 degrees. Ionospheric wave tilt allows the directivity inducing mechanism described above to produce excellent directivity in Beverage antennas operated at MF or HF.

While Beverage antennas have excellent directivity, because they are close to lossy earth they do not produce absolute gain (typically -20 to -10 dBi). This is rarely a problem, because the antenna is used at frequencies where there are high levels of atmospheric radio noise. The antenna has very low radiation resistance (less than one ohm) and will rarely be utilized for transmitting. The Beverage antenna is a popular receiving antenna because it offers excellent directivity over a broad bandwidth, albeit with relatively large size.

Directivity is a function of the length of the antenna. While directivity begins to develop at a length of only 0.25 wavelength, directivity becomes more significant at one wavelength and improves steadily until the antenna length reaches a length of about two wavelengths. Its generally accepted among Beverage antenna experts that directivity no longer improves when the antenna is longer than two wavelengths.

Beverages longer than two wavelengths suffer from the phase incoherency of the incoming waves over distances of several wavelengths, resulting in phase incoherency of the currents induced in the antenna that degrades the directivity of the antenna.

The Beverage antenna is most frequently deployed as a single wire. A dual wire variant is sometimes utilized for rearward null steering or for bidirectional switching. The antenna can also be implemented as an array of two to 128 or more elements in broadside, endfire, and staggered configurations offering significantly improved directivity otherwise very difficult to attain at these frequencies. A four element broadside/staggered Beverage array was used by AT&T at their longwave telephone receiver site in Houlton, Maine. Very large phased Beverage arrays of 64 elements or more have been implemented for receiving antennas for Over-the-horizon radar systems.

**Implementation**

A single wire Beverage Antenna is typically a single straight copper wire, between one and two wavelengths long, running parallel to the Earth's surface from the receiver towards the direction of the desired signal. The wire is suspended by insulated supports approximately two meters above the ground. A 470 ohm non-inductive resistor is installed from the far end of the wire to a ground rod, although this value is not critical.

An impedance matching transformer (typically a 9:1 transformer to match the antenna to a 50 ohm transmission line) is used between the transmission line to the receiver and the antenna feedpoint. As an expediency, the transmission line can be connected directly to the end of the antenna and a ground rod usually with satisfactory results.

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http://www.juliantrubin.com/encyclopedia/electronics/beverage_antenna.html