First used in the sky over Europe before World War I, these venerable "sky hooks" remain popular today, even when anchored securely to the ground.

End-Fed Antennas

BY LEW McCOY*, W1ICP

The end-fed Zepp has been a very popular antenna for many years. However, many newer hams don't realize just how excellent this multiband antenna can be. In this article I hope to show you how to use the end-fed Zepp. First, though, I would like to describe the Zepp's origins and give some very important general information about end feeding antennas.

History of the End-Fed Zepp

The Zepp antenna's name was derived from the fact that the zeppelin dirigibles, or airships as they also were known, used this type of antenna. Airships were invented by the French in the mid-1800s and became popular for commercial air transport in the early 1900s. The zeppelin was developed in 1900 by German inventor Ferdinand von Zeppelin. It was designated a "rigid" airship because a metal framework was used and was covered by fabric. There have also been semi-rigid and non-rigid airships, the latter commonly known as blimps.

In a zeppelin, the metal structure inside the vessel contained a gas-filled airbag which provided the lift for the airship. Usually two large engines with propellers drove the craft, many of which were lost to fire because highly flammable gases were used to lift them.

By 1918 the Germans had built a total of 67 zeppelins to be used in WW I. Only 16 survived the war, as they were relatively easy to shoot down. The business of manufacturing zeppelins prospered after WW I, and they were in use commercially until the 750 foot Hindenburg crashed and burned at Lakehurst, New Jersey in 1937. So how does all this relate to the Zepp antenna?

First, these airships began their careers before radio came into widespread use, so antennas became an "add-on" when radios were installed. The Germans decided on an end-fed, trailing antenna that could be tuned so the radio would operate on many different frequencies. I have not been able to track down the frequencies used, but it is safe to assume that they were the frequencies most commonly used in those early days of radio, probably just above our AM broadcast band.

One end of the Zepp was attached to the airship, and the other end trailed behind in the air. The Zepp antennas were a half-wavelength long, and the end that was attached to the airship was fed with open-wire feeders, resulting in a tuned antenna system.

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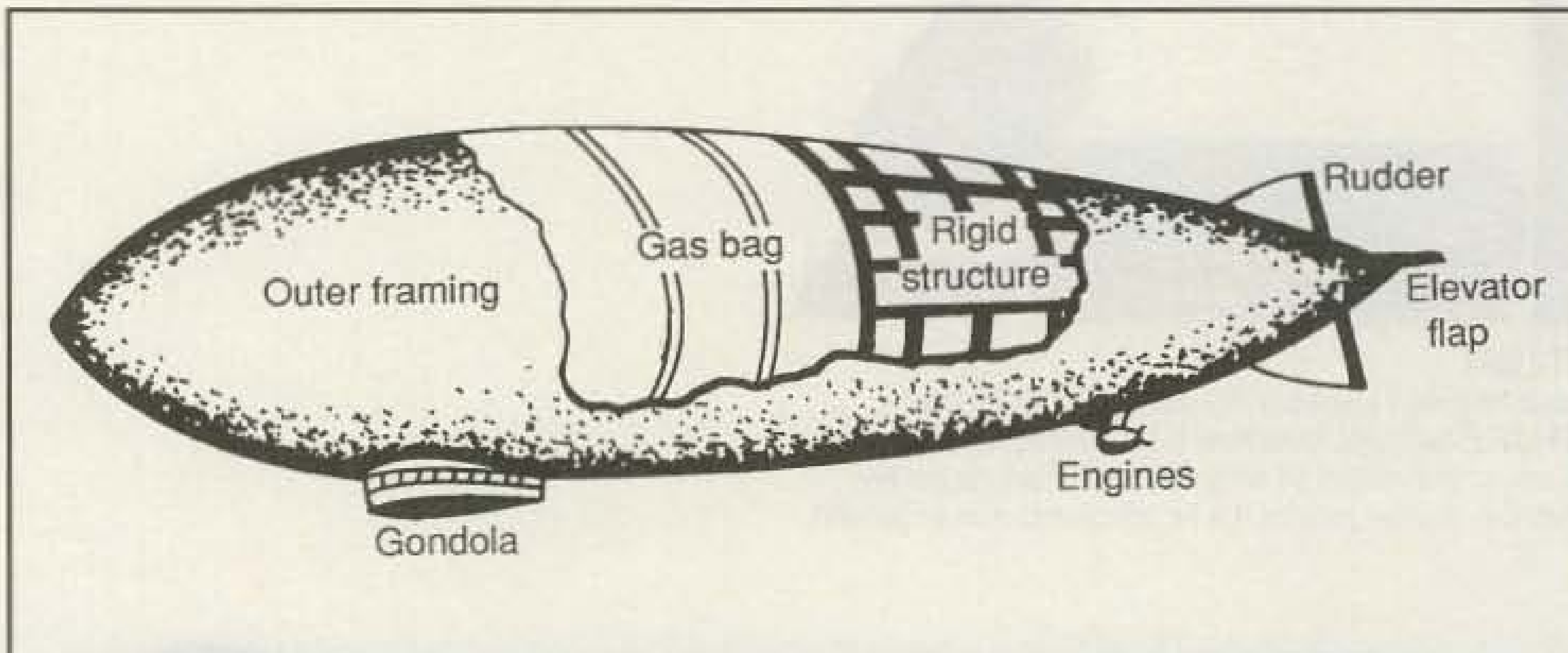

Fig. 1– A cutaway view of a zeppelin, on which Zepp antennas were first used and from which they got their name. For a number of years they were very popular for passenger and freight travel. Some of these ships were longer than a football stadium, so don't try to compare them to the much smaller blimps we see now.

Hams and the Zepp

The Zepp antenna became very popular with amateurs, perhaps because the fed end could be tied to a window or the roof of the house, near the shack, and the other end could be attached to a pole or tower. Fig. 1 is an example of this antenna. Of course, the beauty of this system is that only one support is needed, and that support is usually a tree or a utility pole. Fig. 2 shows the construction details.

Traditionally, end-fed Zepps are fed with open-wire line (usually No. 14 or 12 enamel-covered wire with the conductors spaced 2, 4, or 6 inches apart) or insulated 450 ohm "ladder line." You can use 300 ohm twin lead, but ladder line is preferred. There are many reasons why, and I'll touch on a few here.

These days hams worry themselves into a tizzy over standing-wave ratio (SWR). Coax is very popular as a feed line because it is simple to use, but the problem with coax is that it doesn't tolerate high SWR without serious loss and blowout problems (with high power). It is customary to match the 50 ohm coax impedance to the antenna's impedance to reduce the losses and power problems inherent in the use of coax, but this is not always an easy task. Fig. 3(A) shows a half-wavelength antenna, a dipole, which is fed at the center. The impedance of this antenna, depending on its height above the earth, is close to 50 ohms—at least close enough so that the dipole can be fed with the 50 ohm coax. However, with an end-fed half-wavelength antenna such as the Zepp shown in fig. 3(B), the impedance is somewhere around 4000 ohms, much more difficult to match to 50 ohm coax.

Open-wire or ladder line, on the other hand, doesn't have these problems. The extremely low-loss line can easily tolerate exceptionally high SWRs and power without any problems. To try to make this explanation simple, think about the following:

The end-fed half wave has a very high impedance, somewhere near 4000 ohms, at its end. At its center, the impedance is in the vicinity of 50 to 70 ohms. (You could easily use coax for center feed.) However, assume you end fed this antenna with coax. The SWR, as an example, could be 4000 (the feedpoint impedance) divided by 50 (the coax impedance), or an 80:1 SWR! The losses in the coax would be terrific. However, with the low-loss open-wire line, the 80:1 mismatch could be a piece of cake. You wouldn't have that kind of problem, though. The impedance of ladder line is on the order of 450 ohms, so you would end up with an SWR of only 10 to 1 or so. Using a Transmatch (antenna tuner) in the station provides you with a perfect match when properly adjusted. The Transmatch is really a transformer that transforms the unknown load to 50 ohms so that the transmitter works properly.

An important note: With an end-fed antenna using open-wire or ladder line, one side of the feed line is not connected to anything, while the other side is connected to the end of the antenna. The simplest explanation for this strange setup is simply that a feed line should be balanced, and if it is, one side of the line balances out the other side and no radiation from the line is able to take place. Because of this effect, only one side of the feeders is attached to the antenna. A balun isn't necessary to feed this type of antenna.

Caution: High Voltage!

While this antenna looks simple—and it can be—if you have an incorrect feed-line length, you also have a mess of problems. Here's why: The ends of a half-wavelength antenna have the highest voltage of any point on the antenna. When the feed point is at the high-voltage point, you can run into serious problems, particularly if you use certain lengths of feed line (fig. 4). If a half wavelength of feed line is used on an antenna, the impedance at one end of the line will be repeated at the other end.

When a half-wave antenna such as the Zepp is end-fed, you are looking at a *very high* voltage point, and not just at the antenna. With a half-wavelength feed line that high voltage appears in the shack as well! This can create all kinds of problems. With RF floating around the shack, telephone interference, TVI, and many other types of interference can, and likely will,

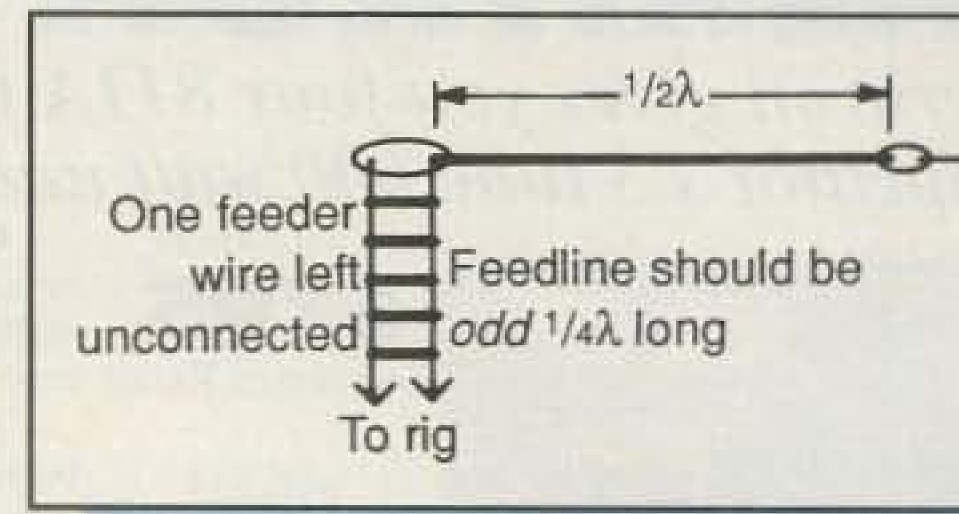

Fig. 2– The end-fed Zepp antenna is a half-wave long, although the antenna can be any length if a wide-range Transmatch is used. Note that the open-wire feed line or ladder line has only one feeder wire connected to the antenna. Normal feedline characteristics are that in a balanced line, such as twin lead, ladder line, or open-wire line, the field from one conductor cancels out the radiation from the other, or vice versa.

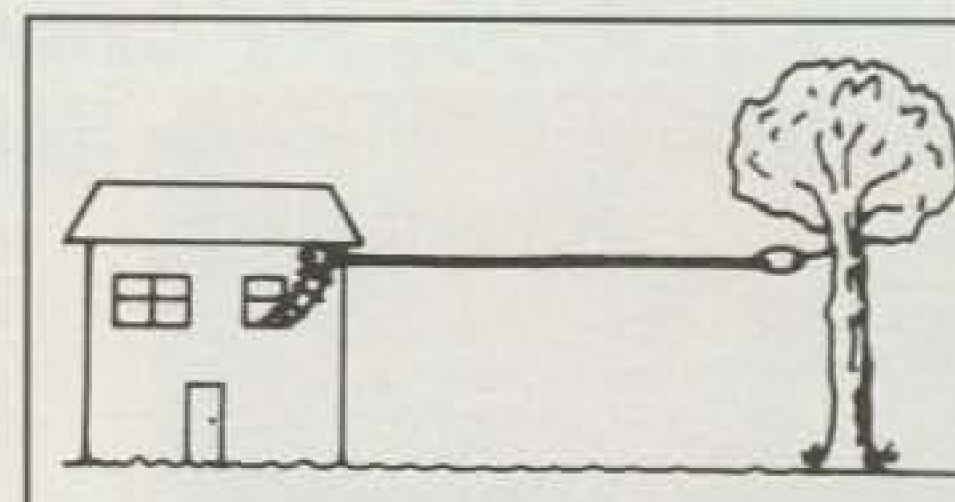

Fig. 3– A typical end-fed installation. A non-conducting line is used to hold the insulator to the house, while the other conductor is soldered to the end of the antenna. A tree or pole is used to support the other end.

occur. The same applies to any multiple of a half wavelength. On the other hand, if you use a quarter wavelength of feed line, or odd multiples of a quarter wave, then the situation changes markedly, and the high voltage at the feed point is not repeated down in the shack. The simple solution here is to make the feed in odd multiples of a quarter wave, which would get rid of the high RF voltage problems.

But wait. Assume you make an end-fed 40 meter half-wave antenna, say, 60-plus feet long. With the open-wire type ladder line this is a multiband antenna. It will also work on 80 and all the higher bands with a good Transmatch. Keep in mind, however, that the feed-line length becomes critical. As you change bands, what is an odd quarter-wavelength line on 40 can become an even multiple of a half-wavelength—and thus a voltage-fed line—on other bands.

A simple answer that worked for me was to make several lengths of insulated ladder line that I simply coiled up and then used clip leads on the ends to attach these lengths to my 40 meter feed line. This, in effect, presents a different and more suit-

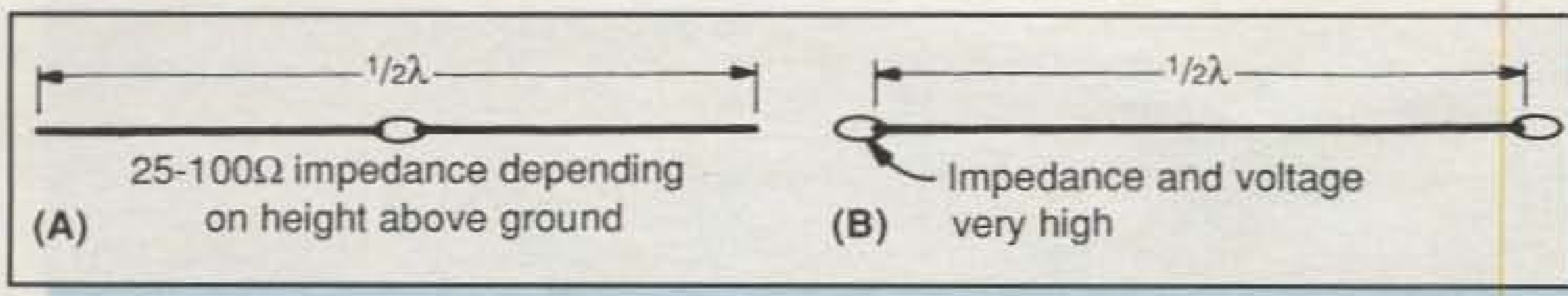

Fig. 4– At (A) is a normal center-fed dipole. At the feedpoint (the center) its impedance is anywhere from 25 to 100 ohms. Depending on its height above earth, the resistance and voltage are low at this point. At (B) is a Zepp antenna, also a half wave, the same length as at (A), but fed at the end. Keep in mind that this is a high-voltage feedpoint. (See text for ways to keep high voltage out of your shack.) Both the dipole and the Zepp have very similar radiation characteristics.

able matching load for troublesome bands. For example, a quarter-wave line at 40 meters is a little more than 33 feet (using the formula 234/f [MHz]). On 80 meters a quarter wavelength is about 60 feet. Therefore, I attach a 27 foot coil of ladder line to my 40 meter quarter-wave line when I want to operate on 80. By the way, the lengths don't have to be exact as long as they're near a quarter-wavelength long. I know some of the experts out there will say I am wrong about coiling up feed-line lengths, but believe me, it works. I'll repeat this statement to drive it home: *Always use odd number multiples of a quarter wave of feed line with end feed.*

A couple of other points about end-fed antennas are in order here. It is useful to know that an end-fed antenna of half wavelength is just as good a performer as a center-fed half-wave antenna (and under many circumstances, it is better than an off-center-fed antenna).

Another time-worn trick used by amateurs with an end-fed Zepp is to tie the feeders together at the Transmatch end and feed the antenna as a random wire. If you're using a 40 meter half-wave antenna, such a feed might make the system a fairly good 80 meter antenna and will even work on 160. However, always remember the need to keep the feed line at an odd multiple of a quarter wavelength.

Random-Length End-Fed Antennas

Finally, let's discuss random-length end-fed wires, or if you insist, "long"-wire antennas. A long-wire antenna, just to keep the record and history correct, is customarily several wavelengths long.

For your most popular band, be sure to make your wire as close to an odd quarter wavelength as possible. I would assume that you are going to bring the end of the wire directly into the rig, or Transmatch. If you have to run it under a window, be sure to use insulation around the wire and keep the wire as much in the clear as possible. On many occasions I have brought my antenna line directly into my shack, but I have been careful to install the wires so that no one can get near the antenna. RF burns can be nasty.

An end-fed random wire needs to be counterbalanced with a grounding wire. Always try to make ground wires as short as possible. Most beginners never think about it, but let's look at an example.

Suppose you have your transceiver sitting on your operating table, and let's say that you are on the third or fourth floor. Your end-fed wire is 60 feet long, so your grounding wire should also be 60 feet long. Think about that statement for a minute. Your rig is actually center-feeding 120 feet of wire. This might make an excellent 80 meter antenna. The problem with grounding from a shack is that you never —and I mean never—really know where actual ground is. Just keep in mind that even numbers of half waves will end up as voltage feeds; odd-number lengths mean low voltage, and that's what you want in your shack.

How long should you make a random wire? The general answer is easy: Make it as long as possible, and you will start to experience gain in the direction of the wire. Put the wire as high as possible. Electric fence wire is still usually cheap and makes good long wires.

A friend of mine coined an expression which is absolutely true: Always put your antenna as high up as possible and make it as big as possible. If the darn thing stays up, it isn't big enough or high enough! Good luck!