WIRE ANTENNAS FOR HAMS and SWL's

There are some antennas that, although developed long ago, are still useful today. We'll present some of those designs and provide you with some sources for such hardware.

BY JOSEPH J. CARR

Among my many hobby interests is a devotion to antique radio receivers, antique transmitters, and the old books and magazines that taught people to build them. It is difficult for me to pass up either a reprint or original Hugo Gernsback magazine from the era when radio was an expensive novelty. Some of those old publications reveal a number of good wire-antenna designs that are still useful today. Indeed, some of them are still in common daily use, while others are less well known. This article is no mere trip down nostalgia lane, but rather a technical look at some antennas that you might want to consider for yourself.

Tee Antennas. The Tee antenna (shown in Fig. 1) is especially suited to shortwave listeners, although ham operators have used them. The Tee antenna is a length of wire 40 to 100-feet long that is fed at the center by another wire, called the downlead. The antenna element can be bare, but the downlead should be insulated 12-, 14-, or 16-gauge wire. The antenna element should be made of 14-gauge Copperweld wire. That type of wire has a steel core coated with copper. Because of the skin effect, RF only flows on the surface, so the steel core does not add losses to the circuit. If Copperweld is not available, then at least use hard-drawn stranded copper wire. If regular soft-drawn wire is used, then it will soon fatigue and the antenna will fall down.

The downlead can be brought to the receiver by way of a small hole cut into the wall of the house, or through the window. At the antenna end, it is wrapped five to seven times around the antenna element wire, and then soldered. The purpose of the solder is not strength, but rather to prevent corrosion of the joint in weather. Wrapping the wire provides added strength.

Random-Length Long-Wire Antennas. The term long wire is used for a wide variety of different antennas. The only rigorously correct usage of the term is for antennas that are more than two wavelengths long. However, it is common to use the term long wire for antennas that are actually random-length wire antennas (see Fig. 2). If the antenna element is, say, 100-feet long, then it is a long wire at frequencies of 20-MHz and up, and a random-length antenna for lower frequencies.

The random-length long-wire antenna of Fig. 2 is a 40- to 150-foot long run of 14-gauge or larger wire (again, Copperweld is preferred). In the case shown, the end closest to the house is supported by a mast installed on the roof while the far end has a stand-alone support. However, both ends could be attached to buildings, trees, or other structures. The downlead of the random-length antenna must be insulated, but need not be Copperweld wire. Ordinary 14-gauge stranded wire will suffice.

If the random-length antenna is used for transmitting, then a good ground must be provided. In fact, a "good ground" is also useful for receive-only installations, but for hams it is a must. A "good ground" means a short run of heavy wire to one or more 8-foot ground rods. Alternatively, if only a few bands are used, then a system of resonant quarter-wave radials can be provided. Technically speaking, they can be left on the surface, but that's not safe even if there is no chance of a family member crossing over the area (even trespassers can sue you!). For the sake of safety, bury the radials a few inches under the earth.

Also required for good transmission, and useful for SWL's as well, is an antenna tuner. A standard L-section coupler, or some other low-to-high impedance-transforming coupler will do.

A variation on that theme is to add the device shown in Fig. 3. The wire antenna and downlead are similar to the ones in Fig. 2. However, at the feed end you have the ability to select direct coupling to the rig, capacitive coupling for antennas that are too long for the operating frequency, and an inductor for frequencies that require a longer antenna. The minimum and maximum values for the inductor and the capacitor are shown in Fig. 3. Use the lower values for antennas that are predominantly in the high end of the HF spectrum, and the larger ones for lower frequencies.

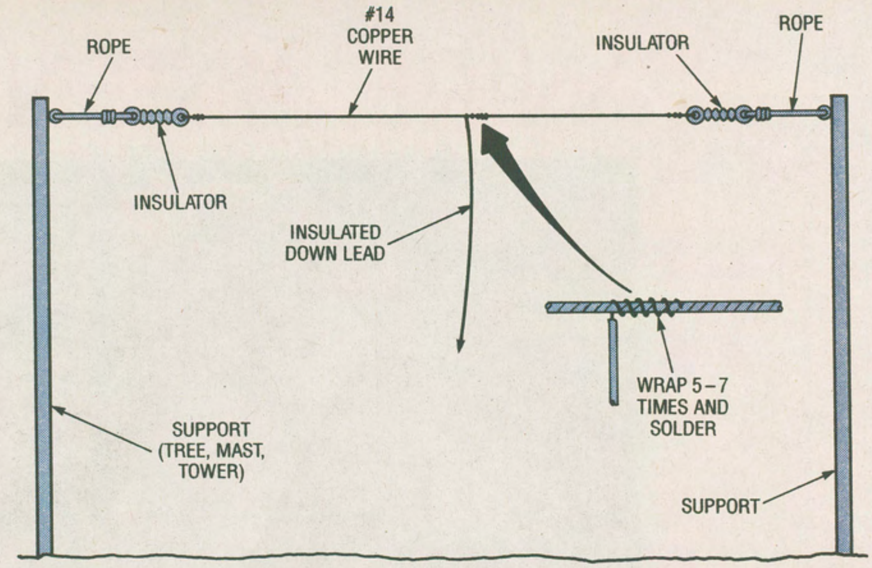


Fig. 1. The Tee antenna is a length of wire 40 to 100-feet long that is fed at the center by another wire, called the downlead.

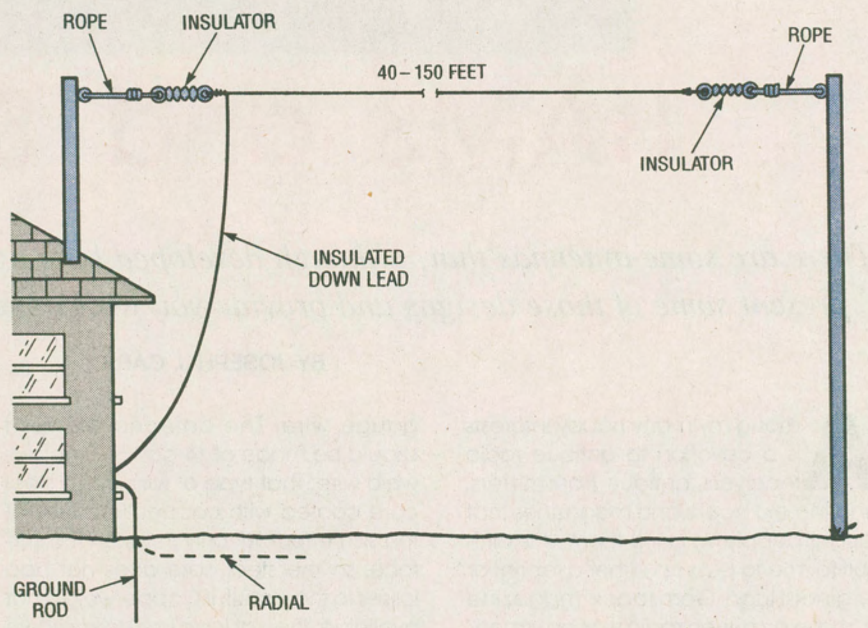


Fig. 2. It is common to use the term long wire for antennas that are actually random-length wire antennas. If the antenna element is, say, 100-feet long, then it is a long wire at frequencies of 20 MHz and up, and a random-length antenna for lower frequencies.

Doublet Antennas. A doublet antenna is one that is fed in the center. Unlike the Tee antenna, the doublet is broken in the middle and each half is fed by one side of a two-conductor transmission line. If the doublet is a half-wavelength long, then each half is a quarter wavelength. The overall length of such an antenna is found from:

$$L = 468/f$$

Where L is the length in feet, and f is the frequency in megahertz. Each quarter-wavelength element is one-half that length.

Keep in mind that, although equations for antenna length look absolute, they are only approximations. The actual length is determined by the immediate locale, and what's in it that'll alter the antenna characteristics (houses, trees, etc). For proper operation, the antenna will have to be tuned, which we'll discuss later.

Figure 4 shows the basic form of the half-wave doublet. That type of antenna is usually called the dipole, and today is most often fed with 75-ohm coaxial cable. But in older designs, two other types of feedline were often used.

Shown in Fig. 4 is a form of line called twisted pair. The two insulated conductors are twisted together. You can either buy twisted-pair wire, or make it using a hand drill and two lengths of regular stranded hook-up wire. Use about eight twists per foot. The other form of two-wire transmission line is ordinary lamp cord (called zip cord). You can buy either 14- or 16-gauge zip cord at most hardware or electrical supply stores.

Figure 5 shows the folded dipole form of doublet antenna. Again, the overall length of the antenna is a half wavelength. The folded dipole consists of two half-wavelength radiators that are closely coupled to each other. The two radiators are insulated from each other at all points except the very ends, where they are shorted together. The feedpoint is at the middle of one of the radiators. That form of antenna has a feedpoint impedance of around 280 ohms, so it is a good match for 300-ohm twin-lead (TV-antenna wire).

The radiator element of the folded dipole can be made using 300-ohm twinlead if only used for receiving, or low-power transmitting, but if higher power-levels are contemplated you

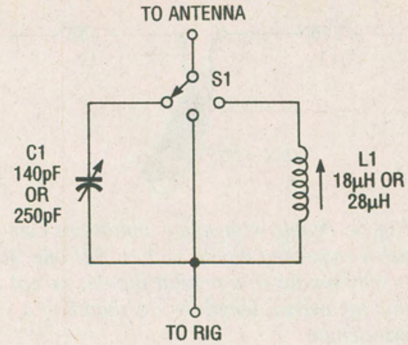


Fig. 3. This little device when placed between the antenna and rig gives you the ability to select direct coupling to the rig, capacitive coupling for antennas that are too long for the operating frequency, and an inductor for frequencies that require a longer antenna.

should use 14-gauge stranded wire spaced 4- to 8-inches apart. The ideal spacers are the ceramic types once found in abundance in radio stores, but lucite, PVC, or even treated (waterproofed) wooden dowels can be used. The detail in Fig. 5 shows how to connect the spreaders to the antenna wires, and how to use safety wires to keep them in place.

Another means of feeding the folded dipole is to replace the center insulator with a 4:1 balun transformer. These low-cost devices will transform the 300-ohm balanced impedance of the folded dipole down to 75-ohms unbalanced so that ordinary coaxial cable can be used.

Still another form of doublet antenna is the three-wire folded dipole of Fig. 6. That form of antenna is similar to the standard two-wire folded dipole, but it uses three parallel conductors instead of two. The conductors are kept insulated from each other except at the far ends, where they are connected together. The impedance of the three-wire folded dipole is controllable by varying the ratio of the conductor diameters and their relative spacing. For our purposes, however, a simplified arrangement is used in which all three conductors have the same diameter, and they are all spaced from each other by 4.5 to 5 inches. That arrangement will yield a feedpoint impedance of about 600 ohms, so it is a good match to a 600-ohm parallel feedline.

Those Winsome Windoms. The windom antenna is a half-wavelength wire antenna that is fed off center. Because the mid-point of the half-wavelength antenna is the low point (about 70 ohms), the off-center feedpoint is at a higher impedance. Figure 7 shows the classic windom antenna used in the 1930's. The single-conductor downlead feed point is 0.36L, where L is the length of the antenna as given by the equation provided earlier. The windom antenna is usually fed through an antenna coupler so that its impedance can be matched to the lower impedance of the transmitter or receiver.

Figure 8 shows a modified windom design in which the single-wire downlead is replaced with either 300-ohm twin-lead transmission line, or a 4:1 balun transformer that is in turn fed with 75-ohm coaxial cable. The antenna does not provide an ideal impedance match, and one can expect (as with both windoms) some "RF in the shack" when more than moderate power levels are used. However, the VSWR is not terribly high and can be overcome using a standard coax-to-coax "line flattener" form of antenna tuner.

An actual kit for a modified form of windom antenna called the Carolina Windom is shown at the beginning of this article. Designed and produced by The Radio Works (Box 6159, Portsmouth, VA 23703; Tel. 1-804-484-0140), the Carolina Windom kit is available in both 80–10 meter and 40–10 meter versions. According to the literature that came with the antenna, the Carolina Windom offers a low VSWR on 75/80 meters, but must be matched with an antenna tuner on higher frequencies. One of the keys to the Carolina Windom antenna

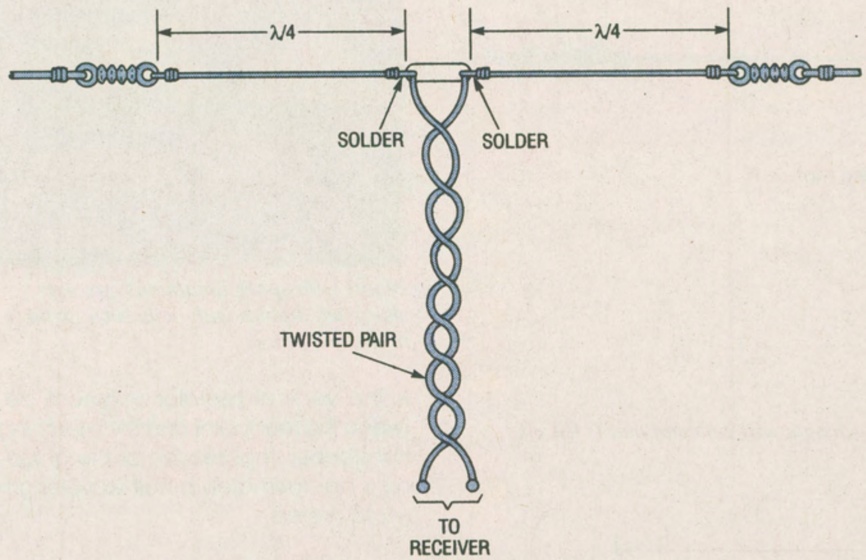


Fig. 4. This half-wave doublet (or dipole), is most often today fed with 75-ohm coaxial cable. But in older designs two other types of feedline were often used.

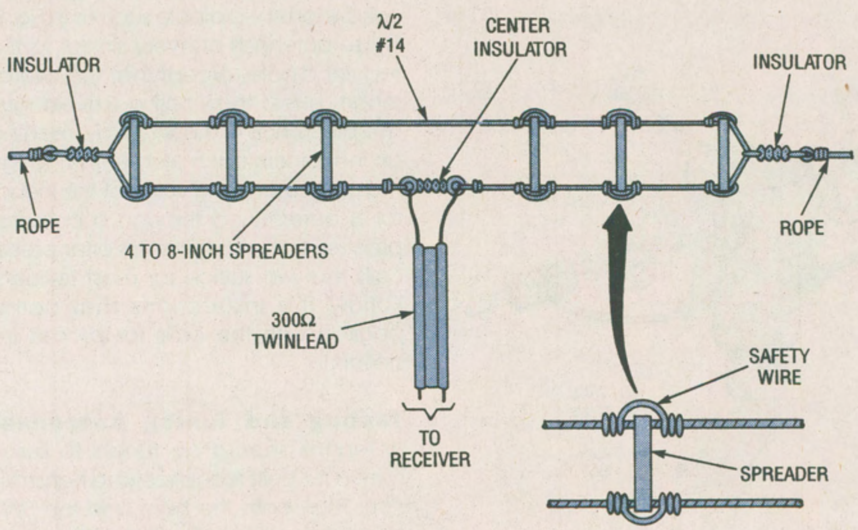


Fig. 5. This is a folded dipole form of doublet antenna. It consists of two half-wavelength radiators that are closely coupled to each other.

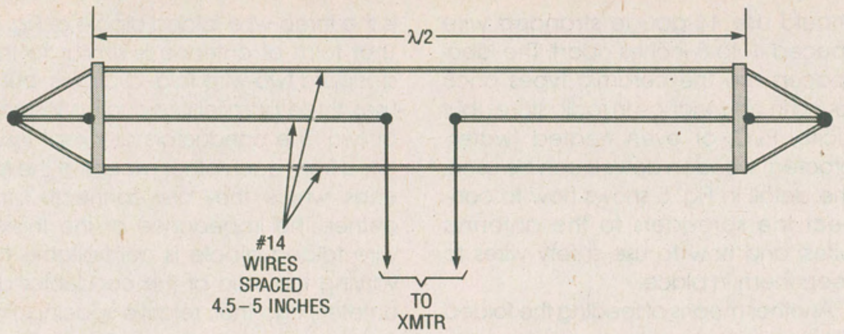


Fig. 6. Another form of doublet antenna is the three-wire folded dipole. It is similar to the standard two-wire folded dipole, but it uses three parallel conductors instead of two.

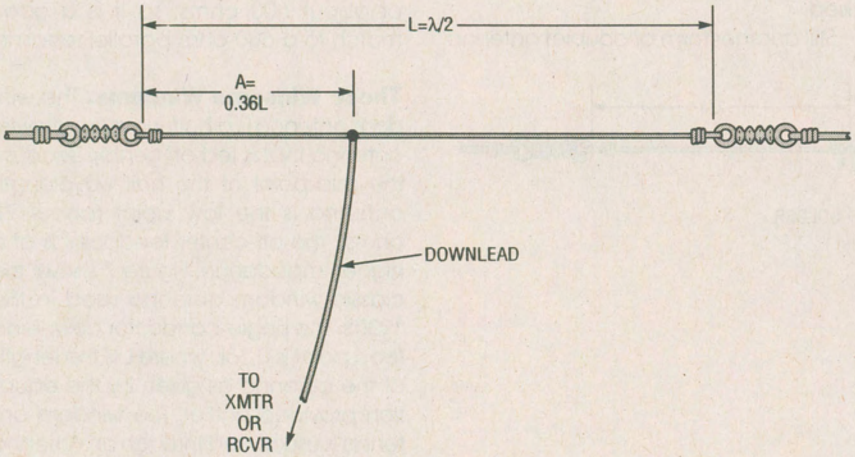


Fig. 7. The classic windom antenna is a half-wavelength wire antenna that is fed off center. The design dates from the 1930's.

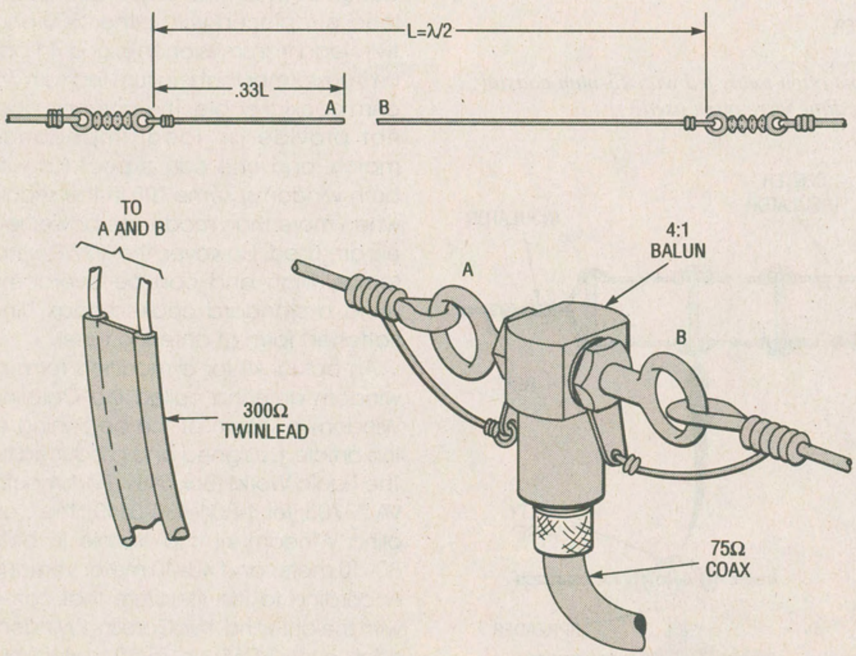


Fig. 8. This is just a modified windom design in which the single-wire downlead is replaced with either 300-ohm twin-lead transmission line, or a 4:1 balun transformer and 75-ohm coax.

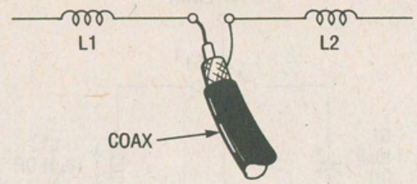


Fig. 9. People with space limitations can use a shortened dipole such as this one. It is very similar to a regular dipole, except that the overall length is less than half a wavelength.

People with space limitations can use shortened dipoles with coils such as these in the two poles.

is the vertical radiator segment between the feedpoint and the matching transformer. That section of the antenna is approximately a half-wavelength on 15-meters.

Shortened Dipole. Some shortwave enthusiasts cannot easily erect a half-wavelength antenna because of space limitations. Those people can use a shortened dipole such as in Fig. 9. Those antennas are very similar to the regular dipole, except that the overall length is less than half a wavelength. The difference is made up by inserting an inductor in each element. Although the placement and value of the inductor is determined through a complex process, some companies offer preset coils that will suffice for most readers. Follow the instructions that come packed with the coils for proper installation.

Testing and Tuning Antennas. Antennas should be tuned to resonance for best reception and transmission. Thus, both the ham and the SWL need some means for finding the resonant point. The ham can always use a

(Continued on page 84)

WIRE ANTENNAS

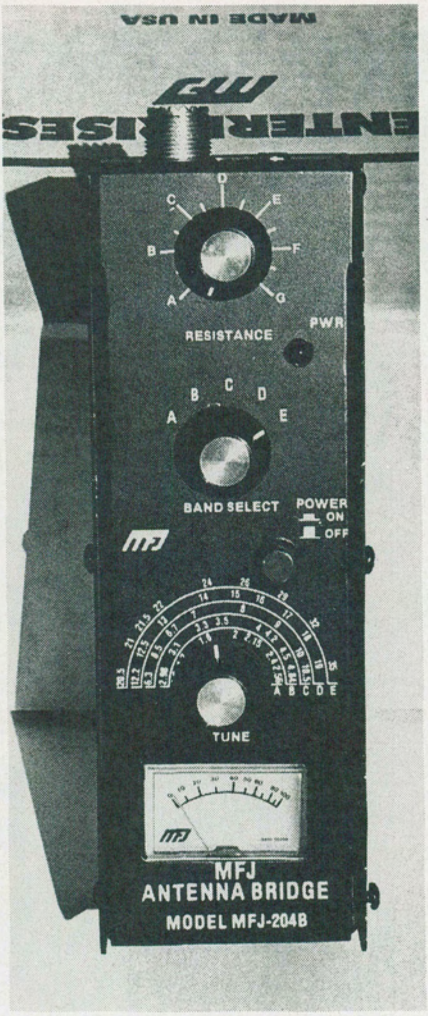
(Continued from page 52)

VSWR meter or RF power meter to find the point of least reflected power (lowest VSWR). However, the SWL cannot use the transmitter method, so some other means must be found.

A useful tool that I've used (for both ham and SWL antennas) is the MFJ Enterprises, Inc. (Box 494, Mississippi State, MS, 39762; Tel. 601-323-5869) MFJ-204B antenna impedance bridge. Unlike other Z bridges that only hams can use, the MFJ-204B has an internal RF-signal generator that will supply the signal that both both hams and SWL's need to find the antenna impedance.

This instrument can handle resistive impedances up to 500 ohms, and covers all HF bands up to 30 MHz. Although the MFJ-204B has a dial, I like the fact that it also has an output jack for a digital frequency counter. That little option makes it possible to very accurately locate the frequency. It also allows you to use the internal signal generator for other jobs. If for some reason you can't get right to the antenna feedpoint terminals, then use a half-wavelength section of transmission line to reflect the feedpoint impedance back to the instrument.

There are two ways to use the Z bridge. First, set the frequency selector to the desired resonant frequency, and then adjust the impedance knob for minimum deflection of the meter needle. The impedance where that null occurs is the antenna impedance that must be matched. Second, adjust the impedance and frequency to that which is desired, and then adjust the antenna length to minimize meter-needle deflection. One thing to keep in mind—despite what you might have heard to the contrary, the feedline length does not control the antenna resonance point. Only the length of the antenna element will tune the antenna!



This Z bridge contains a built-in RF generator. That's very helpful to shortwave listeners as they have no broadcast equipment.

All radio antennas work better if the impedance of the antenna is matched to the impedance of the transmission line, and the line impedance is matched to the receiver or transmitter. Both hams and SWL's can use antenna-impedance matching networks for that job, although the ham versions seem a little easier to obtain. Fortunately, companies like MFJ make antenna tuners for both hams and SWL's. Their model MFJ-955 is intended for receiver use at frequencies that range from VLF to 30 MHz. Their differential-T tuner is used for amateur operators using full legal-limit power levels.

This antenna tuner can work from VLF to 30 MHz. It can support two antennas and two transmitters for the well equipped shack.

Wire antennas date back to the very earliest days of radio (even Marconi used a random-length wire antenna). However, they are still viable designs for amateur radio operators and shortwave listeners today. ■