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So Why Do They Call It Wireless?

One easy antenna. Five hot bands. Need we say more?

The centerfed multiband antenna—a favorite with amateurs in the 30s, 40s, and 50s—is enjoying a rebirth in the 80s. The need for frequency versatility (given today's crowded band conditions, especially on 80 and 40 meters) and a modern, simpler design approach to antenna couplers have been the two predominant factors responsible for the renewed popularity of this antenna.

It is unfortunate, however, that most technical literature on this antenna is outdated. Few amateurs today, for example, couple their balanced-line antennas inductively to the transmitter tank coil or use antenna-matching systems that require changing coils or coupling configurations when changing bands. In addition, many of the suppliers of open-wire feedline cited in past literature are no longer in business. Therefore, I have attempted to share in this article a modern design approach to the centerfed multiband antenna which I have gleaned from a review of literature, catalog inquiries, experimentation, and discussions with other amateurs.

Antenna Design and Characteristics

Traditionally, the centerfed multiband antenna is cut at 1/2 wavelength for the lowest desired band. Operation on all higher bands thus will be on multiples of 1/2 wavelength. For example, an antenna cut for 1/2 wavelength on 80 meters will appear as 1 wavelength on 40 meters, 2 wavelengths on 20 meters, 3 wavelengths on 15 meters, and 4 wavelengths on 10 meters. Cutting for 1/2 wavelength at the lowest operating frequency has become accepted practice because the voltage and current distribution, and hence the impedance and radiation patterns, are more easily predicted at multiples of a half wavelength. See Fig. 1 for construction practices and Fig. 2 for radiation pat-

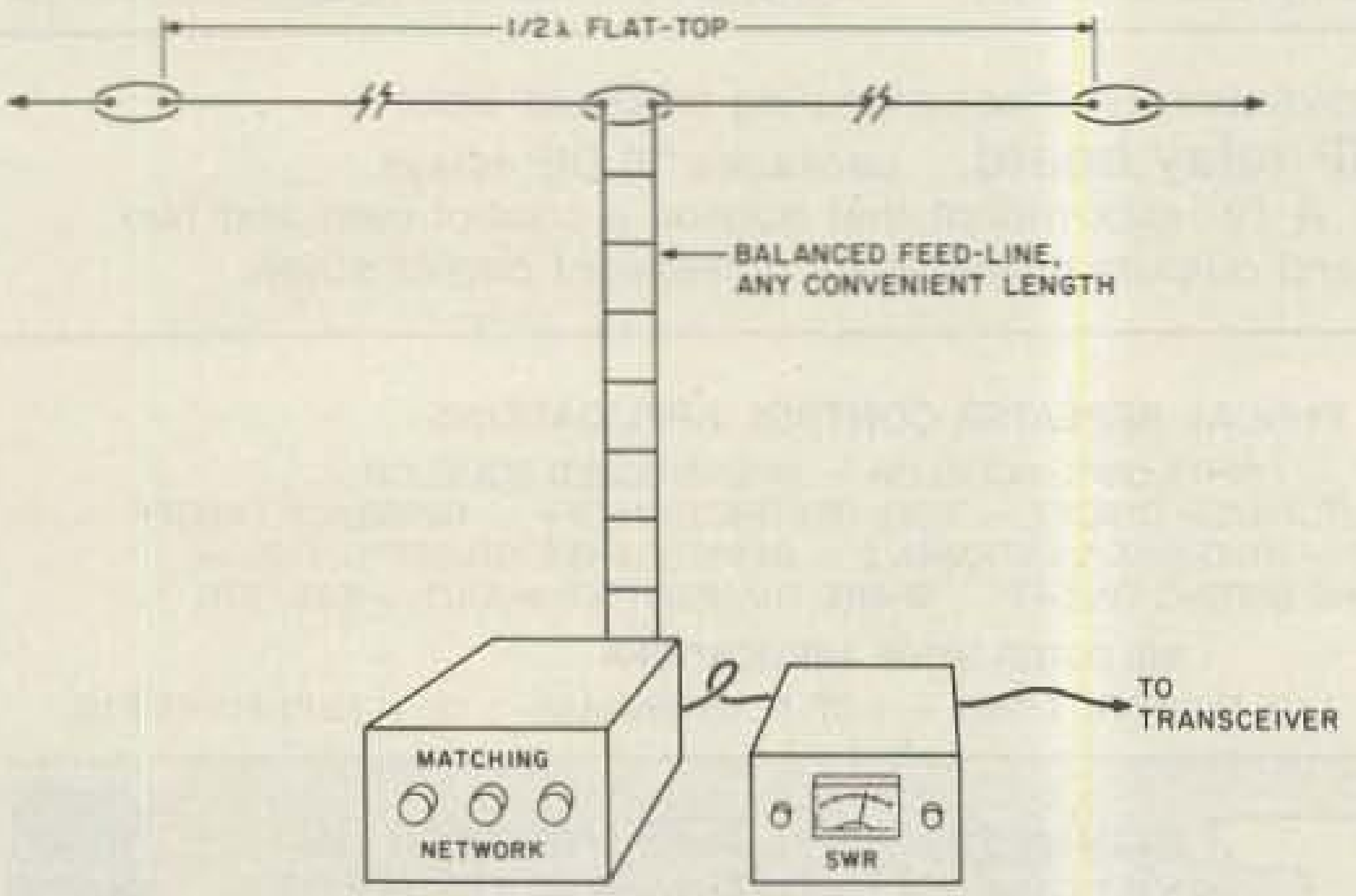

Fig. 1. Full-size version of the centerfed multiband antenna, cut for the lowest band of operation.

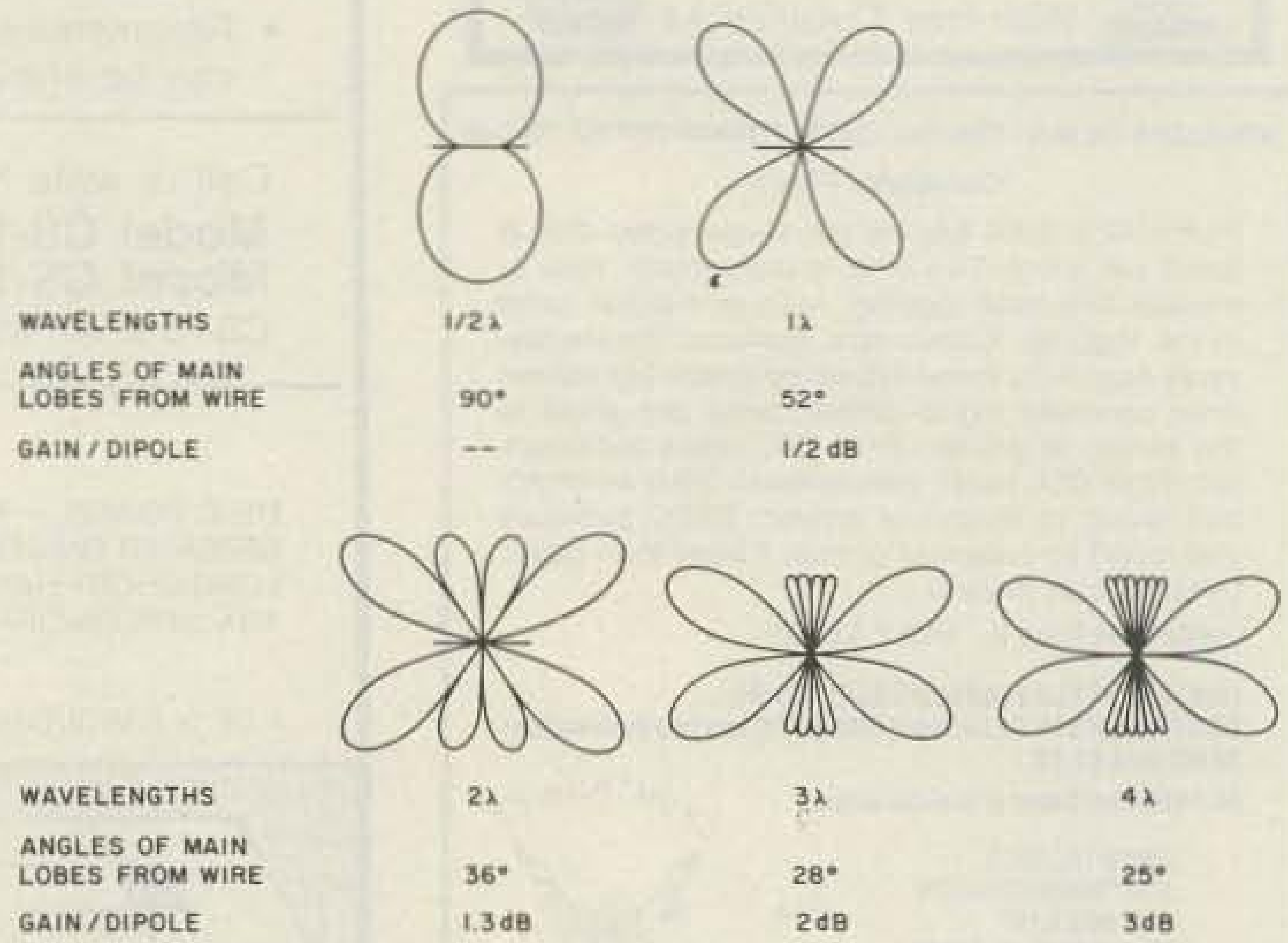

Fig. 2. Characteristics of the antenna.

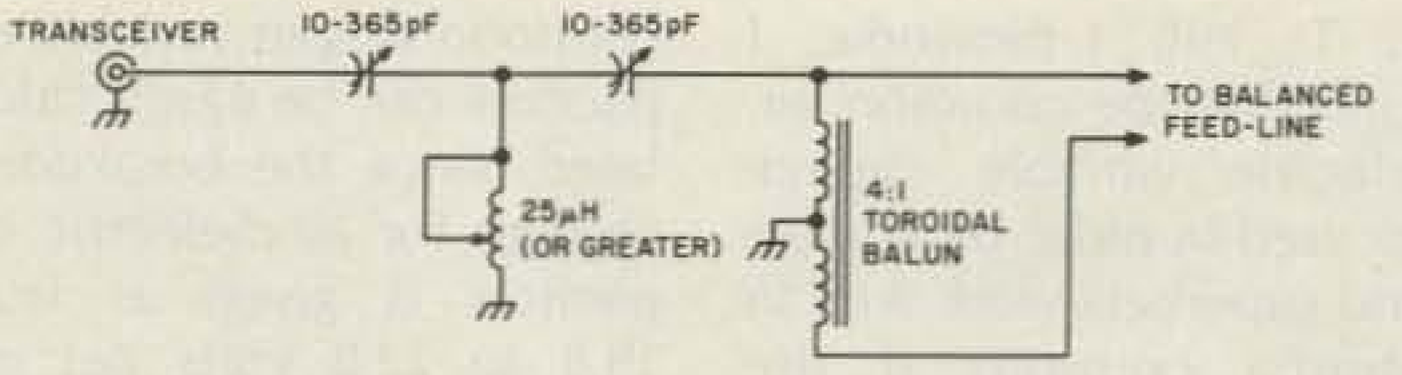

Fig. 3. A T-network with a 4:1 toroidal balun for use in coupling modern transceivers to balanced feedlines.

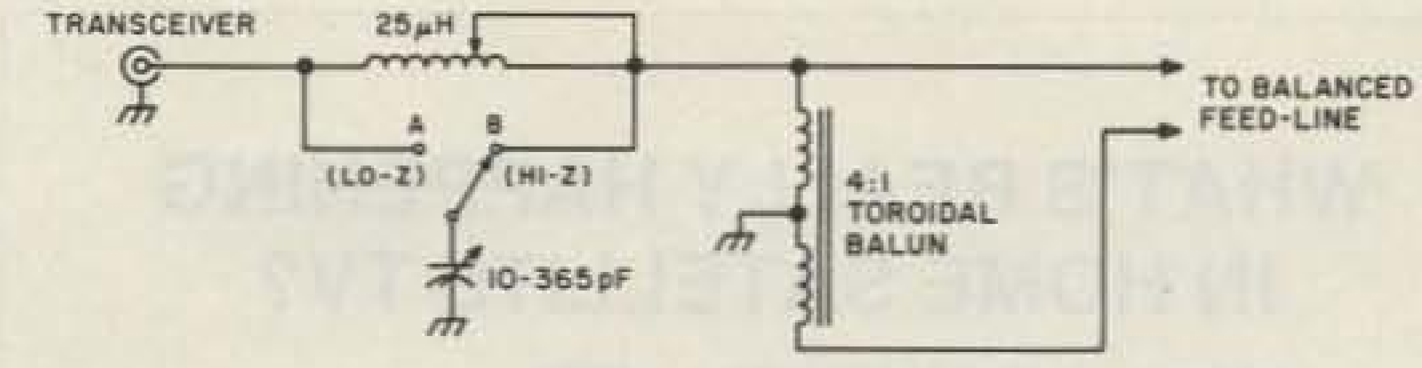

Fig. 4. An L-network coupler for use with balanced feeders.

terns and gain characteristics of this antenna for the 80-10-meter amateur bands.[1,2]

In limited-space situations where it is not feasible to erect a full 1/2-wavelength antenna, the antenna can be shortened and still be effective as long as the total length of half the antenna plus one feeder wire add up to at least 1/4 wavelength at the lowest frequency.[3] In the case of a shortened antenna, a field-strength meter can be used to obtain an approximation of the radiation pattern. The impedance, of course, need not be calculated as long as the antenna-coupling network presents a satisfactory (resistive) load to the transmitter.

Turning to the subject of balanced feedlines for this antenna, there are two popular alternatives. One is to use open-wire line, the other is to use plastic-jacketed twinlead cable. Open-wire line is just that—two parallel exposed wires held apart by ceramic or plastic spacers. It is available in 300- and 450-Ohm impedances.

Four current suppliers of open-wire line are: Radiokit, Box 411, Greenville, New Hampshire; Kilo-tec, Box 1001, Oak View, California; Madison Electronics, 1508 McKinney, Houston, Texas; and Texas Towers, 1108 Summit Avenue, Suite 4, Plano, Texas.[4] Plastic-jacketed television twinlead is readily available in almost all electronics stores and is generally acceptable for transmitters with outputs of 250 Watts or less. Belden makes a heavier-duty twinlead specifically for transmission purposes which is rated at 1 kW. Their product number for this twinlead is 8235.

The decision to employ open-wire line or twinlead should be made after considering the relative advantages and disadvantages of each. Open-wire line has the lowest loss but is less rugged and more difficult to support than twinlead. In addition, since the wires are not insulated, care should be taken not to route open-wire line where people could inadvertently come in contact with it. Twinlead, on the other hand, has greater loss, especially when wet. It is easier to route, however, as high-quality, TV-type standoffs can be used. Also, the heavy-duty twinlead is exceptionally rugged. (I have used the same heavy-duty twinlead at my Michigan QTH for ten years, where it has been exposed to ice, high winds, and low temperatures.)

The Antenna-Coupling Network

Prior to about 1970, most amateurs either coupled their transmitters to balanced lines through pi-network output stages and air-wound coil baluns or used various switchable series and parallel antenna-coupling networks. Today, with the advent of solid-state transceivers which require a nominal 50-Ohm resistive load for the antenna, an external antenna-coupling network is necessary to couple to 300- or 450-Ohm balanced lines.

The matching network almost universally used today is the T-match with a 4:1 toroidal balun. (It was largely the availability of the compact toroidal balun, which can easily be enclosed in the antenna-coupler chassis box, that led to the wide acceptance of this design by amateurs.) An experimental T-network coupler that I assembled from surplus parts is shown in Fig. 3.[5] Various modifications of this design are used in most kit or assembled "antenna tuners." (The term "antenna tuner" was not used in this article as it is actually a misnomer. A more accurate term for this device would be an "antenna-coupling network," since its primary purpose is to couple or match the line/antenna to the nominal 50-Ohm load requirements of the transceiver.)

To use the T-network coupler, first set both variable capacitors to a half-open position. Then, using low transmit power (5 or 10 Watts in the "tune" position), tap the inductor a winding at a time until a dip in swr is indicated. After the proper coil winding is tapped, alternately adjust the two capacitors for the lowest swr. If the swr is less than 1.5:1, apply full power to the coupler since the tuning process is now complete.

An Alternate Coupling Network

The reversible L-network, with the addition of a 4:1 toroidal balun, can also be used to match 300- or 450-Ohm balanced lines. The L-network requires only one variable capacitor, unlike the T-network which requires two. The trade-off in using the L-network over the T-network is that the Q of the L-network is less uniform over the coupling range. This presents little problem, however, if harmonic attenuation of the transmitter is sufficient. (Transmitters and transceivers marketed in 1979 or later generally have sufficient harmonic attenuation, as federal law mandated stricter emission and radiation standards about this time.) An experimental L-network that I built is shown in Fig. 4.

To use the L-network, select tap A for low impedances and tap B for high impedances. Next, select the coil tap that indicates minimum swr; then fine-tune the variable capacitor for the lowest swr. If the swr is less than 1.5:1, switch the transceiver from tune to full power since the tuning process is now complete.

Antenna-Coupler Construction Practices

For the amateur who has not constructed antenna-coupling units before, a few words about the subject are in order.

First of all, it might be helpful to know that complete information on winding toroidal baluns (along with a list of parts suppliers) can be found in almost any late edition of the ARRL handbook.[6] The appropriate section of the book will be listed in the index under "baluns."

To construct the air-wound coils required by the two antenna couplers, it is important to know the required coil radius, the coil length, and the number of coil turns for a given inductance. A formula to approximate the inductance of air-core coils is:

$$L = a^2n^2/(9a + 10b)$$

where L = inductance in microhenrys, a = coil radius in inches, b = coil length in inches, and n = number of turns.[7]

Regarding the selection of variable capacitors for

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the T- and L-networks, I found that the common air-dielectric variable capacitors used in older broadcast-band superhets work well in antenna couplers if the transmitter power output is less than 50 Watts. For higher-power transmitting applications, air variables with wider plate spacings are needed. These transmitter-type variables usually can be found at hamfests or can be purchased from larger amateur-radio supply houses.

A formula that can be used to calculate the capacitance of an unknown variable capacitor is:

$$C = .224KA/d \times (n-1)$$

where C = capacitance in pF, K = dielectric constant of material between plates (use 1.0 for air), A = area of one side of one plate in square inches, d = separation of plate surfaces in inches, and n = number of plates.[7]

Breakdown ratings for common air-gap variable capacitors can be easily calculated, since the breakdown voltage for air-dielectric capacitors is given as from 19.8 to 22.8 volts per mil (.001 inch).[8] This information is obviously useful when tube-type linears are used ahead of the antenna tuner. ■

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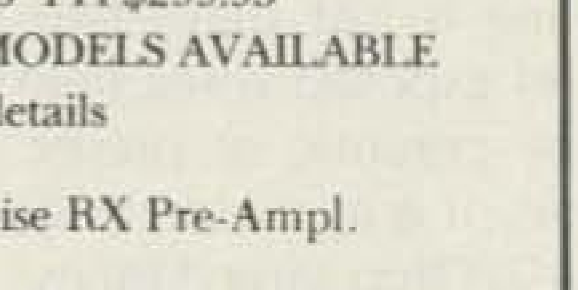

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