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Extended Double Zepp

—old-timer's delight still works

My first transmitting antenna, way back in 1929, was a full-wave centerfed radiator with open-wire line-tuned feeders, commonly known at that time as a "double Zepp." As amateur radio progressed, this antenna became known as a "pair of half waves in phase." Still later, another version appeared and was called the "extended double Zepp" antenna. The very latest version used 5/8-wavelength elements and had about 3 dB gain over a half-wave dipole. As any old-timer can tell you, these were potent DX antennas in their heyday, especially when you remember that 50 Watts was "high power" and the latest store-bought receiver was the National SW-3.

Strange as it may seem, the horizontal antennas to be described here were installed as part of a research project on phased and driven vertical arrays with which I was associated during 1976 and 1977. For this project, we needed several reference antennas with horizontal polarization and definitely known gain characteristics. It was desirable that the antenna gains were on the order of 0, 3, and 6 dB; it was essential for a "perfect" match to be obtained between each antenna, reference or otherwise, and its transmission line. The use of coaxial transmission lines was necessary so that we could switch the lines at the transmitter for "instant" comparisons between antennas. The first antenna installed was a half-wave dipole fed at the center with a 1:1 ratio toroidal coil balun and RG-11/U (75-Ohm) line. Since this antenna is not unusual in any way, it is not described here.

The Extended Double Zepp

The second reference antenna was the extended double Zepp with 5/8-wavelength elements. The design frequency for the 15 meter experiments was 21.3 MHz. Normally, the two 225° elements are each cut to a length equal (in feet) to 600/f, where f is in MHz. For 21.3 MHz, the elements L1 and L2 are each 28 feet, 2 inches long. Element lengths for other frequencies may be calculated or taken from Table 1.

In most handbooks, an open-ended stub is shown connected to this antenna at the center, as shown in Fig. 1 at "A". If the distance between the points "o"-"o" and "x"-"x" is equal to 1/8 wavelength, the impedance across the line at the "x"-"x" points will be about 120 Ohms. If you make the open-wire stub 3/8-wavelength long from points "o"-"o" to points "z"-"z", you can obtain any value of impedance along the line as you move from the open end of the stub (very high impedance) toward the point where the stub connects to the antenna elements (low impedance).

Since you need to use an RG-8/U (50-Ohm) coaxial line and a 4:1 ratio toroidal coil balun to match the line and antenna, you will find the appropriate 200-Ohm impedance point down the stub from the antenna at 6 feet, 10 inches. This point, marked "y"-"y" in Fig. 1, is correct for 21.3 MHz. For other frequencies, the distance between points "o"-"o" and "y"-"y" can be calculated from the formula in which the distance in feet equals 145.69/f, where f is in MHz.

If you use RG-11/U (75-Ohm) line, the correct

300-Ohm matching point will be a few inches further down the line in the direction toward the open end. It must be understood that these calculated points of attachment are intended to bring you within the ball park and, in some cases, may be exactly correct. However, the antenna must be resonated and matched as outlined below. The overall stub length for 21.3 MHz will be 15 feet, 4 inches. For other frequencies, use the formula in which the distance in feet equals 326.52/f, where f is in MHz.

The stub is constructed from two no. 12 copper conductors spaced 4 inches apart by means of porcelain spreaders. The two radiator elements are also made from the same size wire. Ordinary plastic-covered household electrical wire, obtainable at any hardware or electrical supply store, is suitable. If you cannot obtain the porcelain spreaders, use plastic rod or hardwood dowels to make the spreaders. In the "old" days, we used maplewood dowels and boiled them in linseed oil to prevent the absorption of moisture.

The Adjustments

The antenna system may be easily matched and resonated for optimum performance if you follow each step in order as follows.

Calculate the length of the two radiator elements and the matching stub from the formulas or select them from Table 1. Cut the wires about 2 or 3 inches longer than the calculated lengths to allow for trimming adjustments during the resonating process. Connect the stub to the antenna elements as shown in Fig. 1.

Calculate the distance of the 200-Ohm impedance point down the stub from the antenna. Once the point is located, peel the insulation from the two wires for a distance of about 4 inches on each side of the calculated and measured point. The output terminals of the balun are connected to the two bare stub wires with flexible leads not over 8 inches long and a pair of copper alligator clips.

Connect an swr meter in series with the coaxial transmission line and the balun input terminal (test point "A"). Raise the antenna at least 10 feet above the ground.

At the transmitter end of the coaxial line, apply a 21.3 MHz rf signal at a level of about 5 Watts. Adjust the swr meter sensitivity and/or the signal level until the swr meter indicator reads exactly full-scale "forward." Throw the swr meter selector switch to "reflected" or "reverse." The reverse indication should be much lower than that obtained with the switch in forward position, but the indicator may not read zero. Move the two alligator clips up or down the bare stub wires to locate the point where the reverse swr indication is the lowest.

The antenna should be pulled up to a half wavelength above ground while observing the swr meter reverse indication. If it is inconvenient to read the swr meter indication when the antenna is raised, connect a half-wavelength piece of coaxial line between the swr meter output terminal and the balun input terminal. Use any type of coax for the half-wave section and any impedance, but make sure that it is exactly a half-wave long. If it is, the swr meter readings will be the same as when connected to a balun input.

If you cannot obtain a complete null (zero indication) on the swr meter indicator by adjusting the two alligator clips, adjust the clips for the lowest indication. Now, trim an inch or so from the length of each radiator element and again adjust the alligator clips for a null. The clip adjustments are not very critical, but an inch or so removed from the radiators or the stub will have a very noticeable effect. By alternately trimming the radiator and stub lengths very carefully and sliding the alligator clips up and down the bare wires of the stub, you should be able to obtain a complete null on the swr meter indicator.

A complete null or zero reverse reading indicates a perfect match between the line and the antenna feedpoint, or an swr of 1:1. In our antennas, with a perfect match at 21.3 MHz, the swr was not more than 1.2:1 at the frequency extremes of the 15 meter phone band. The final adjustments are made so that the swr meter indicates zero reverse when the

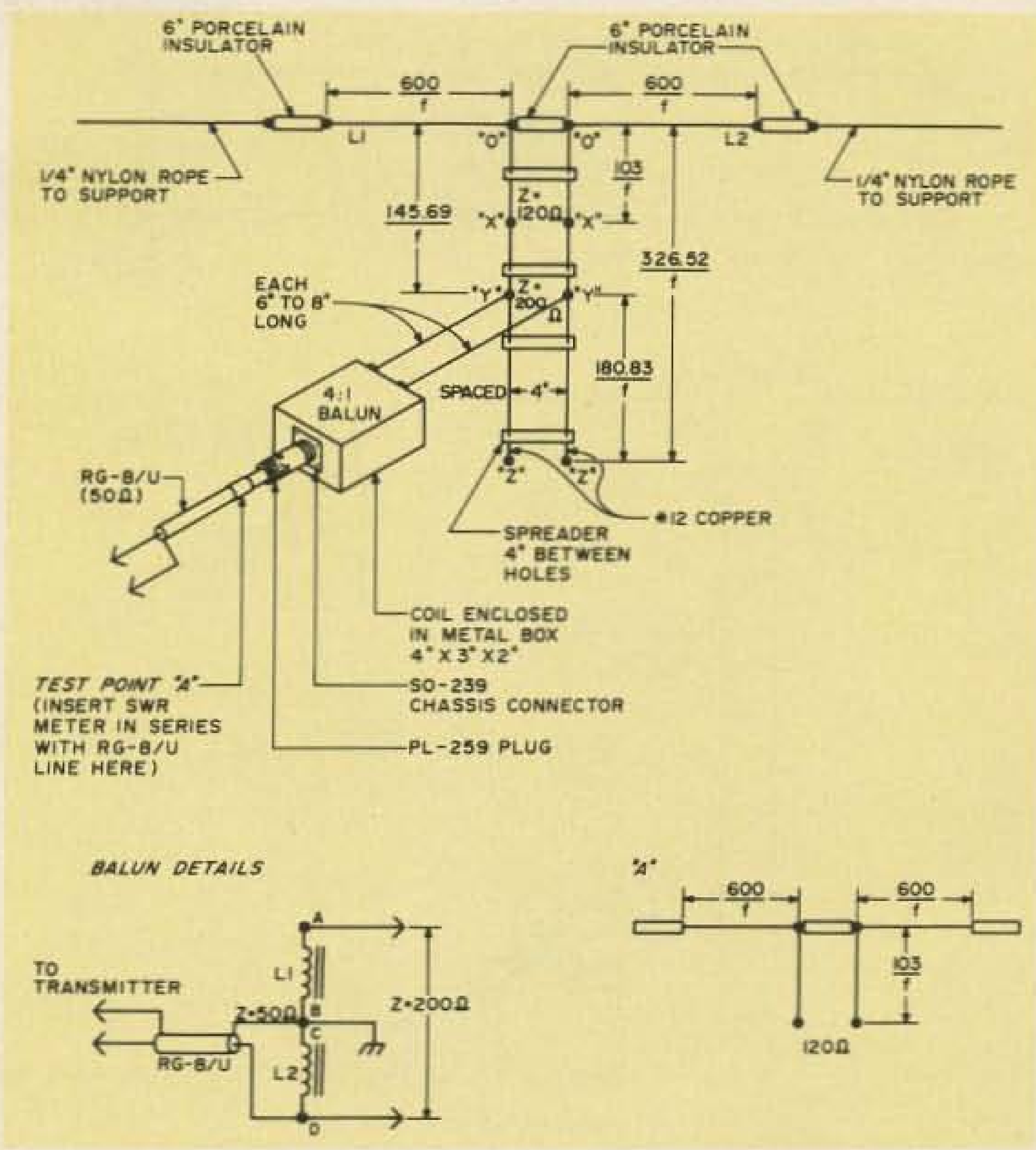

Fig. 1. Extended double Zepp antenna with coaxial line feed. Gain = 3 dB over half-wave dipole at same height; f = megahertz. Dimensions for 21.3 MHz—L1 = 28'2"; L2 = 28'2"; "'o"-"y" (200 Ohms) = 6'10"; "o"-"z" = 15'4"; adjust "o"-"z" dimension and "y" positions for lowest swr at test point "A". L1-2—two 13-turn coils #12 copper, Teflon™ insulated bifilar wound on 2" powdered-iron core (T-2).

Frequency	L1	L2	o-x	o-y*	o-z
3.750 MHz	160'	160'	27.47'	38.85'	87.0'
7.150 MHz	84'	84'	14.41'	20.38'	45.67'
14.175 MHz	42.3'	42.3'	7.27'	10.28'	23.0'
21.300 MHz	28.17'	28.17'	4.84'	6.84'	15.33'
28.600 MHz	21.0'	21.0'	3.60'	5.09'	11.42'

*Table 1. These dimensions are for the antenna shown in Fig. 1. *Adjust as required. See text.*

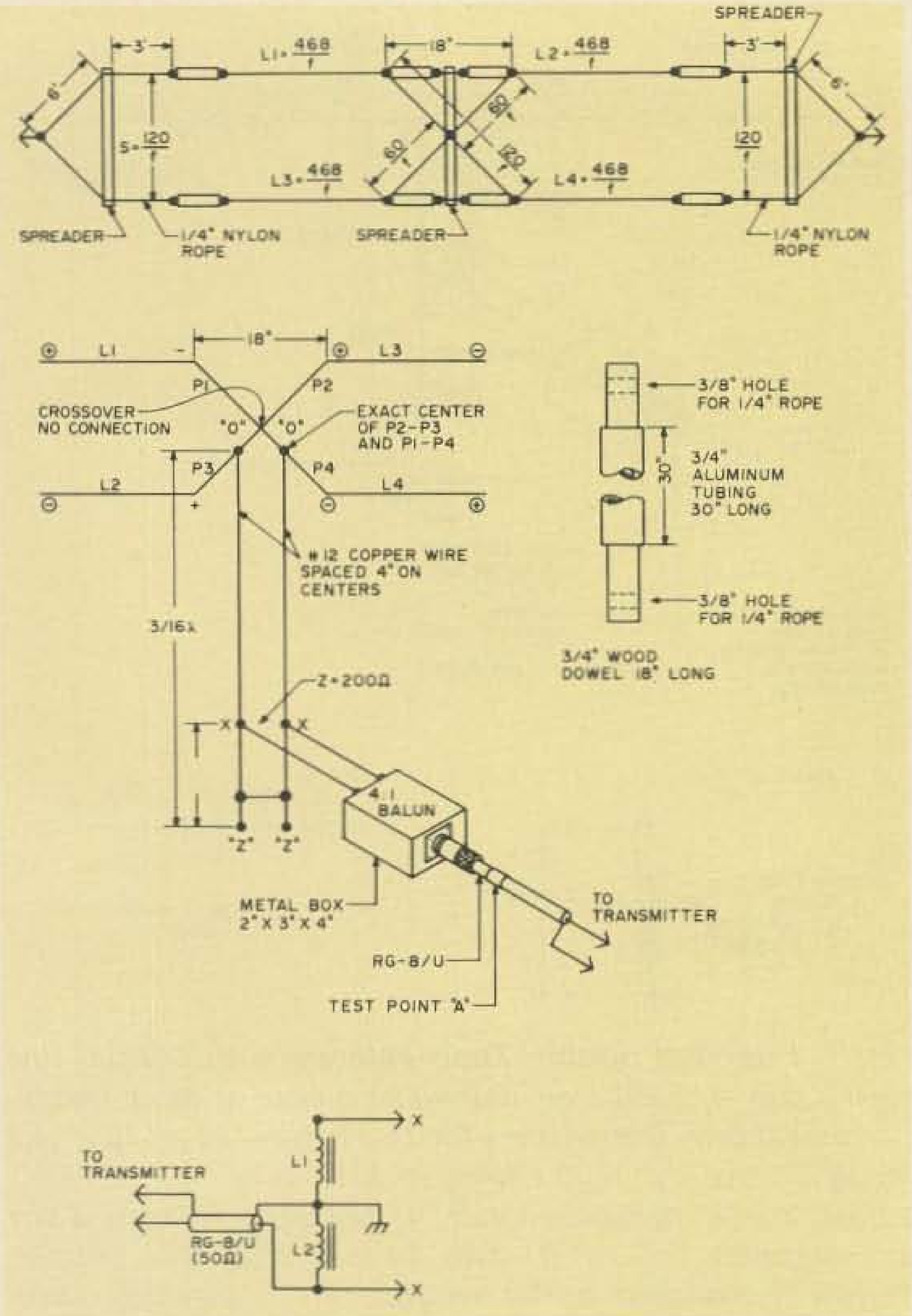

Fig. 2. Four-element array. Gain = 6.2 dB over a half-wave dipole at same height. Dimensions for 21.3 MHz—L1 = 22′; L2 = 22′; L3 = 22′; L4 = 22′; S = 5′7-1/2″; stub (3/16λ) = 8′5-1/2″ between point "o"-"o" and "z"-"z"; 200 point = 24″ between "x"-"x" and "z"-"z". For other frequencies, use the formulas. L1-2—13 turns each bifilar wound on 2″ powdered-iron (T-2) core. Use #12 or #14 copper wire with Teflon insulation. Enclose it in a 2″ × 3″ × 4″ metal box.

antenna is suspended a half wave (about 23 feet for 21.3 MHz) above the earth.

The Four-Element End-Fire Array

Back in the "stone age" of amateur radio, this antenna was generally called an "8JK beam" after the amateur (John D. Kraus W8JK) who originated and publicized it in the technical journals. The version shown in Fig. 2 consists of four half-wave elements—L1, L2, L3, and L4. When the phasing section is connected as shown, elements L1 and L4 will be excited in phase. Elements L2 and L3 are also excited in phase. However, the currents flowing in L1 and L3 and the currents in L2 and L4 will be out of phase by 180° (observe the instantaneous polarity symbols in Fig. 2).

This type of arrangement produces what is called an "end-fire" array. Maximum radiation will take place along a line through the plane of the radiators and at right angles to the four elements. The pattern is bidirectional, and the gain over a half-wave dipole at the same height is about 6.2 dB. Until now, the big drawback with this antenna was that all published designs showed the use of cumbersome tuned feeders or 600-Ohm open-wire lines. In this array, the method of feed is even easier to adjust than that of the extended double Zepp antenna previously described.

The four radiator elements must be exactly the same length. Use the half-wave formula in which length in feet equals 468/f, where f is in MHz. For 21.3 MHz, each element is 21.97 (22) feet long. If the elements are cut precisely to this length and the array is erected exactly one-half wavelength above electrical ground, no adjustments of the element lengths are necessary. The phasing harness conductors P1, P2, P3, and P4 must be exactly equal in length. The distance from each stub connection point out to the element connection must be precisely the same, or the array will be unbalanced and incorrectly phased. Incorrect phasing will reduce the gain and may cause other problems.

For stub design purposes, the distance from the stub connection on the phasing harness conductor to the element connection is considered to be 1/16 wavelength. The entire phasing harness is looked upon as two 1/16-wavelength transmission lines in parallel. Therefore, if you make the impedance matching stub equal to 3/16 wavelength as shown, you can connect an adjustable "short circuit" (jumper wire) across the lower end of the stub and use it to resonate the array. Since the 1/16-wavelength phasing harness plus the 3/16-wavelength stub equals 4/16 wavelength, or 1/4 wavelength, the "shorted" stub will have a low impedance value at the bottom and a high impedance value at the top. As a result, you can obtain any impedance value by tapping across the stub at the appropriate point along the line.

The 200-Ohm impedance point for the connection of the balun output terminals is about 24 inches up the stub from the jumper wire. Again, I want to emphasize that the impedance connection points are only approximations. Bare the stub conductors and slide the alligator clips up and down for lowest swr indication in the coaxial line at test point "A". If a complete null cannot be obtained with the alligator clip adjustments, move the jumper wire up or down the stub and readjust the clips until a reverse zero swr meter indication is obtained. Once the correct adjustments have been made, solder the jumper wire across the stub and clip off the unused ends of the stub. At the balun connection, remove the alligator clips and solder the balun output leads directly to the stub conductors at the exact points where the clips were attached. The final adjustments should be made with the elements suspended a half wavelength above ground.

Summary

These antenna systems are actually much easier to adjust than the above description might indicate. The only test equipment required is an swr meter and a low-power signal source whose frequency can be accurately controlled. The average Novice should be able to construct and adjust these "beam" antennas if the instructions are carefully followed. The extened double Zepp antenna will effectively double your radiated power. The 4-element job will give you an effective radiated power gain of four times. All references are to a half-wave dipole at the same height. ■