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the TRIPLE DUPLEX BEAM

by ALAN BIGGS, W8LO/W2ZW/?

It is the general amateur practice to consider the current loop resistance of a center-fed half-wave dipole as being of 70 ohms impedance. However, when a second half wave length of wire is located parallel to the first, and fed in phase, the close spacing tends to increase the current loop resistance. When a third half-wave very closely spaced radiator is added, the loop resistance reaches a value wherein the method of feeding and matching may be greatly simplified. John D. Kraus, W8JK, developed this idea of very closely spaced half-wave radiators into what was called the *Twin-Three Flat-top Beam.*

The advantages of the Twin-Three were: (1) broad band frequency response (greater than the folded dipole), (2) excellent matching characteristics, necessitating no tuning adjustments other than accomplished with a yardstick, (3) very high radiating efficiency and (4) good wet weather performance. Although quite a few Twin-Three beams were erected a disadvantage arose from the time-consuming and tedious job of cutting and laying out of 600-ohm feeder lines—not to mention the occasional requisition of neighbors to aid in extricating the constructor from a hopeless tangle of feeders and antennas. With the current developments in twin-lead feeders, there is no reason why the advantages of the Twin-Three should not now far outweigh its disadvantages.

Modernizing The Twin-Three

The first step in modernizing the Twin-Three is to provide for using the common 300-ohm twin-lead. An examination of *Fig. 1* shows that if two half-wave dipoles are fed with a phase difference of 180 degrees and spaced 1/6th wavelength apart, their center impedance will be approximately 16½ ohms. The use of three closely spaced dipoles instead of the simple doublets will raise this center impedance by a factor of nine, or to 150 ohms.

A quarter-wave matching section made of 300-ohm twin-lead may be used to match that 150 ohms to a 600-ohm line. However, this 600-ohm termination in parallel with the 600-ohm termination of the quarter-wave section from the other three-wire section results in 300 ohms, or a perfect match if a 300-ohm twin-lead

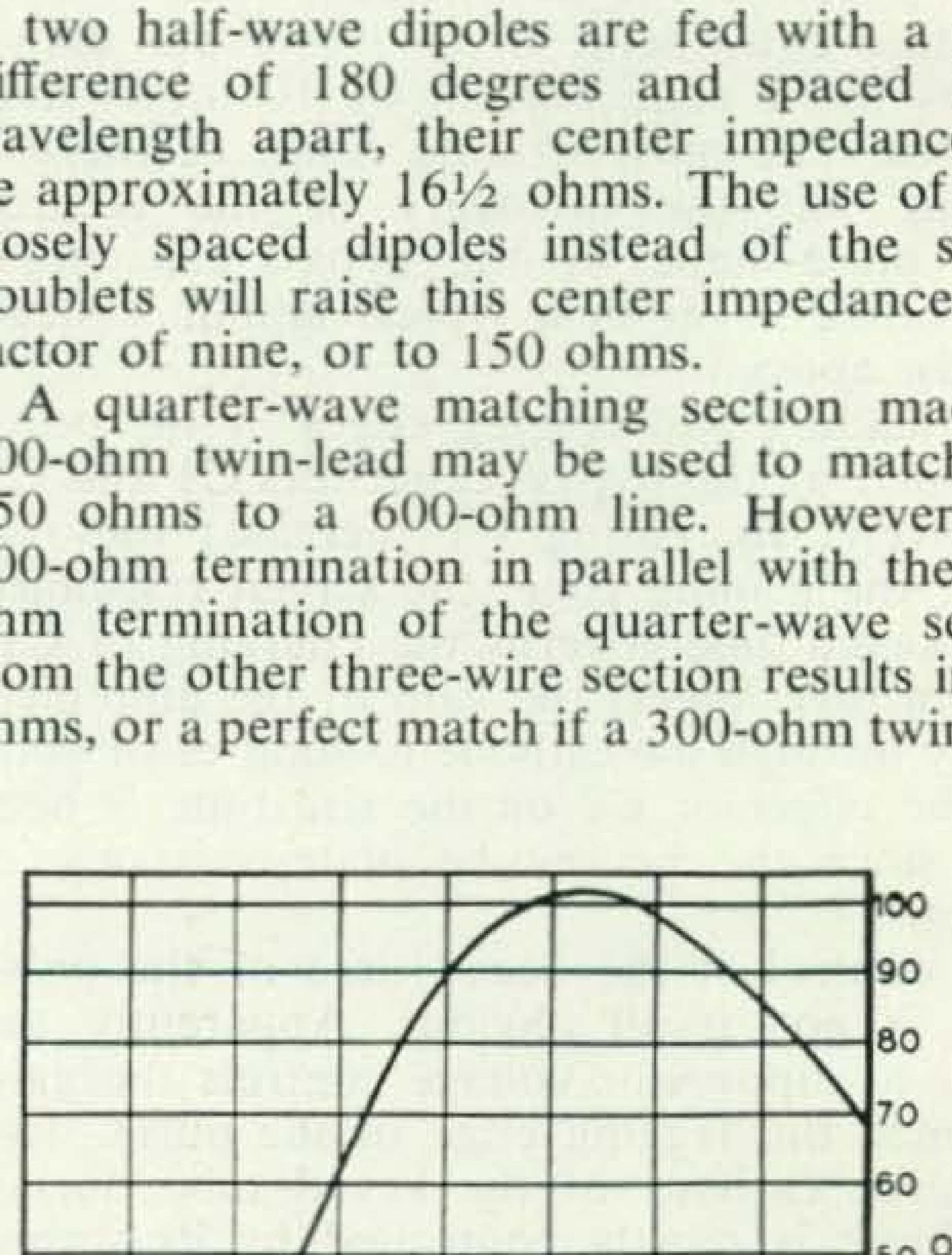

Fig. 1. Effective Center impedance of two dipoles in free space fed 180 degrees out of phase.

line is used as a feeder from the transmitter. One of the quarter-wave sections must be transposed in order to get the necessary 180-degree phase difference in the two three-wire radiators. This is accomplished by an intentional twist in the twin-lead 300 ohm line coming from one of the radiating sections.

Published information on what constitutes a quarter wavelength of 300 ohm twin-lead line differs so widely that we determined our matching sections experimentally. This was done with a v.f.o., a flashlight bulb, and a small piece of twin-lead that had been weathered for about three months. We found that the formula

$$\frac{246}{f\,(\text{in mc})} \times 0.835$$

gives the length of a quarter wave section in feet, or 14′ 3½″ for the 20-meter band.

There is little difference in performance whether the ends of the three-wire doublets are open or closed. In view of the simplified construction, it was decided to use the three-wire doublet with the three wires connected together at each end. Since a verbal description is then, "a three-wire folded doublet with ends shorted," and is confusing, Arthur Lynch, W3DKJ, has suggested that such a radiator be called a *Triplex* element. The twin three, with all the modifications which we are suggesting, could then be called the Double Triplex.

Construction

Laying out the beam is simplicity itself. First, obtain two 12′ lengths of 2″ x 1″ redwood or similar hardwood for the spreaders. Stake the two spreaders approximately 33 feet apart on the ground. About 3 inches from the end of one spreader tie the insulator and the first half-wave element. Thread the wire through the lucite center spacer as illustrated in *Part A* of *Fig. 2*. The center element is cut in half and is threaded through holes drilled in the ½-inch round solid piece of lucite, thus breaking the center of the dipole as per usual. The distance between the two holes in the round lucite piece is about 1½″. The third half-wave is threaded on the spacer and the same entire procedure repeated for the twin radiator section.

The quarter-wave matching section is best made of one continuous piece of 300-ohm lead 29 feet long. Each end of this matching section length is cleaned for about 1½ inches and exactly in the center a one-inch space (i.e., ½″ either side of center) is cut out and cleaned. The separation of the plastic insulator in the center is drawn up by twisting the wire off at right angles. This twist is then brought around the outside of a porcelain insulator and joined on to the 300-ohm twin-lead coming in from the transmitter. The insulator is left in place and the whole arrangement as shown in *Part B* of *Fig. 2* is carefully taped. Don't forget that one length of the matching section has an intentional twist for the 180° phasing.

Because the twin lead is so easy to handle, very little time will be lost in getting the whole antenna into the air. The feeders should be made as rigid as possible as this antenna may have a tendency to swing. Generally, however, when the dimensions are followed the array is fairly steady.

The general figure eight horizontal pattern of the Triplex is shown in *Fig. 3*. Naturally, on DX the pattern may appear sharper, but on local contacts it will appear rather broad. At the 40-degree points the power is about 6 db below that of the nose. The height of the beam follows the adage, the higher the better. Probably this has much to do with the angle of radiation since the VSWR does not vary to any great extent with various heights above ground. The Triplex does have one peculiarity, since unusually heavy loading is required. At W8LO, four turns in the coupling link were required, but brought no ill effects. Shortening, or lengthening the feeder by a quarter wavelength may also benefit the loading by taking advantage of the standing wave ratio, which should be less than 2/1.

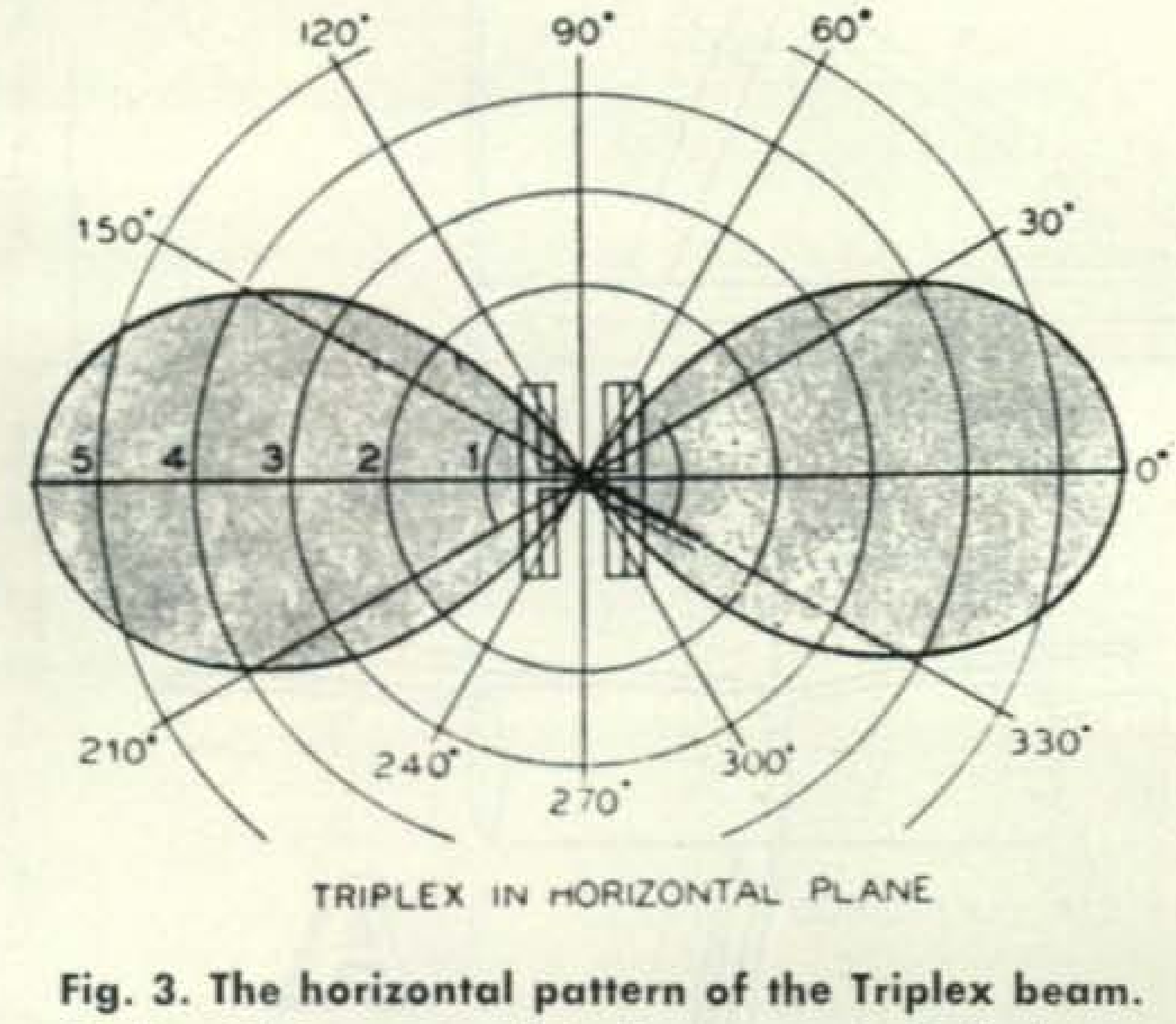

Fig. 3. The horizontal pattern of the Triplex beam. At the 40 degrees points the power is 6 db down from the nose.

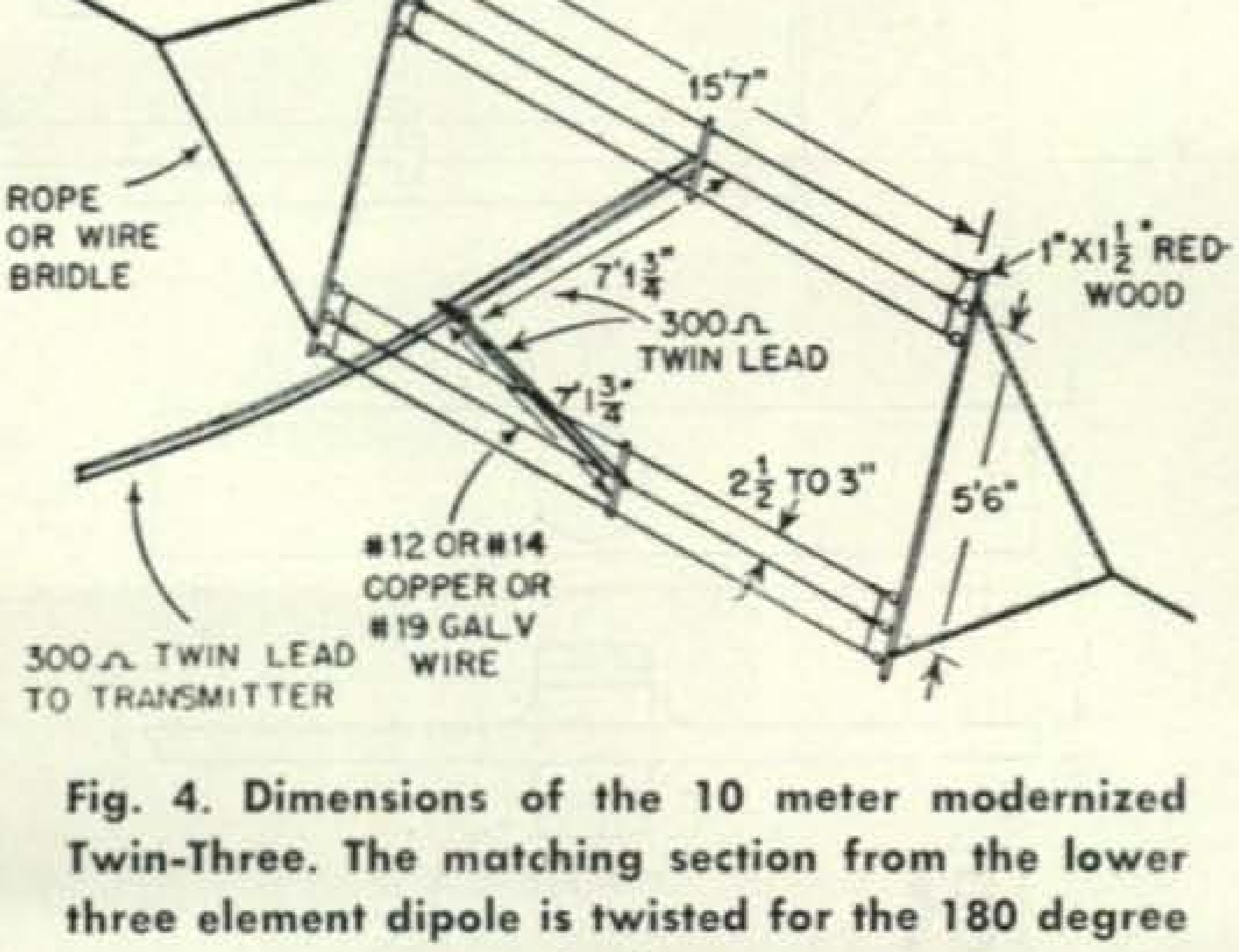

Fig. 4. Dimensions of the 10 meter modernized Twin-Three. The matching section from the lower three element dipole is twisted for the 180 degree phasing.

Performance

One of the most frequent questions we have had regarding the antenna concerns its wet weather performance. Contrary to expectations, the 300 ohm twin-lead performed very well over the four-month period of operation. No rain storm has ever caused the loading to fall off more than 15%. This characteristic has been confirmed by other users of the antenna. W8QQN/5 of San Antonio reported a reduction of only 10% in loading during a downpour. It has been our belief that this reliability under wet weather may be accounted for by the rather unusual quarter-wave "Q" used in this antenna. When the twin-lead becomes wet, its impedance is lowered. As the "Q" section impedance is simultaneously lowered, the over-all mismatch is less.

In order to test the possibility of mounting a 10-meter Double Triplex inside a similar antenna for 20 meters the arrangement was made. For comparison, a 10-meter Double Triplex was erected at the same height with the same orientation. Tests made on the air showed there to be no difference. The one in the clear, however, had less standing waves on the feeders, and its resonant frequency was much broader than the other. The 20-meter performance was in no way altered.

Ten-meter Triplex

To determine the effect of using metal spreaders, a 10-meter Double Triplex was erected with 1" diameter dural spreaders 6' long. Apparently, the capacity effect was such that the Triplex elements had to be shortened to 15' 2½" from the 15' 7" in *Fig. 4*. This indicates that if dural spreaders are used, the 20-meter antenna elements would also need to be shortened slightly.

Two identical ten-meter antennas were set up using #19 galvanized wire and the other using #14 enameled copper. No difference in loading or standing waves could be detected. Checks on the air also showed no difference. Galvanized wire being stronger, cheaper and having less tendency to stretch can be used with complete satisfaction. It may also be easier to obtain than currently scarce copper wire.

Repeated checks have shown the Double Triplex performance on 20 meters to be everything that could be asked of it. The signal compares favorably with those of other stations using the same power and three element beams. At W8LO/2, two twenty-meter Double Triplex beams at right angles to one another afford world coverage. An eight-hour thirty-five minute WAC was accomplished within twelve hours after the second antenna was erected. W5KTL's signal increased an average of two Rs in New York over the folded dipole he had been using. W4HOK's signal with medium power is comparable in New York City to any stations in his area. The first week, using 600 watts and the Double Triplex WAC was worked on ten meters. This included an R 8-9 from India. ■

Fig. 2. Dimensions for the 20 meter Triplex beam shown in plan view. The twin lead junction is illustrated in the closeup view A. The Q sections are made from one continuous 29 foot length of 300 ohm line. The dipole center insulator in the closeup view B is made of lucite.